THE STATE OF INDIA'S ENVIRONMENT 1982

A CITIZENS' REPORT

CENTRE FOR SCIENCE AND ENVIRONMENT

SETON HALL UNIVERSITY
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CENTRE FOR SCIENCE AND ENVIRONMENT
NEW DELHI

TO THE WOMEN OF CHAMOLI

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S7
1982

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CONTENTS

	Introduction	v
1.	Land	1
2.	Water	15
3.	Forests	31
4.	Dams	57
5.	Atmosphere	71
6.	Habitat	91
7.	People	113
8.	Health	125
9.	Energy	145
10.	Wildlife	163
11.	Government	175
	Resources	185
	A Statement	190

This report was edited by Anil Agarwal, Ravi Chopra, and Kalpana Sharma. Details concerning specific contributions can be found in the section "Resources".

The co-operation of the following organizations was critical: the Centre for Tribal Conscientization (Maharashtra); the Dasholi Gram Swarajya Mandal (UP); the Gandhi Peace Foundation (New Delhi); the India Development Service (Karnataka); Kalpavriksha (New Delhi); the Kerala Sastra Sahitya Parishad; Lokayan (Delhi); Oxfam India (New Delhi); the Shahdol Group (MP); and the World Wildlife Fund — India (New Delhi)

Purnima Rao and Mukul Dube were responsible for design and illustrations, the organization of figures, tables, and photographs, and other matters related to planning and production.

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The Word, phototypesetters, and the Ambassador Press have been most co-operative. The contribution of the CSE's secretarial and administrative staff, finally, cannot be overemphasized.

INTRODUCTION

In many ways, this voluntary report on the State of the Environment in India is a unique document. It is the product of an enormous participatory effort. A range of voluntary agencies and individuals interested in environmental issues have contributed their best efforts towards making this report a reality within a span of six months and without a rupee to start with.

The fact that this report has come out in so short a time reflects a growing popular awareness of the environmental crisis engulfing India as well as a strong desire amongst people across the country to know more about what is happening in other parts of the country and to share information available with them. We hope that the report, to be produced annually, will become an important tool in raising still greater public consciousness of environmental issues.

We are not aware of any national report — at least not on this scale — produced by voluntary agencies working together. By writing about a vast array of environmental issues in one place, we have been able to develop a dramatic picture in which the misery of the human condition in our country is mirrored by the sweeping degradation of its environment.

For us, however, even more exciting than the product has been the process by which it has been put together. So, let us tell you the behind-the-scenes story, before we talk some more about the report.

The idea for this report came when one of us, Anil Agarwal of the Centre for Science and Environment (CSE), and K.P. Kannan of the Kerala Sastra Sahitya Parishad (KSSP) attended a conference in Malayasia, last November. There they came across a short monograph on the "State of Malayasian Environment" prepared by the Consumer's Association of Penang. On the flight home, they discussed the possibility of preparing a similar report for India, but much wider in scope. They drew up a list of individuals and organizations who could be asked to contribute.

The Centre for Science and Environment, which operates an information service on science, technology and development issues, could provide the secretariat and some writers. Kannan offered that the KSSP could produce a Malayalam edition. June 5, 1982, the next World Environment Day, seemed to be an appropriate publication date. Anil amd Kannan were already committed to other activities in the coming months. Someone else was needed who could work full time on this project.

In early December, another one of us, Ravi Chopra, agreed to organize the effort. Very soon three major objectives were set:

- The report should be a "citizens' report". Every year, the Government of India gives its version of the state of the nation: its economy, its industry and beginning this year, the environment. There are no authoritative non-governmental publications which assess the state of our nation. To bring out a factual "citizens' report", a wide spectrum of individuals and voluntary organization, working among the people, would have to be involved.
- The report should be published annually.
- The manner in which the report is prepared should be in keeping with a desired set of values which are missing from professional and academic organizations (but are beginning to take roots in some voluntary groups). Thus, we would have to try to be self-reliant, non-hierarchical and non-sexist.

None of us was exactly sure what all this would amount to in practice. But all the same we committed ourselves to trying to fulfill these objectives.

A number of individuals and organizations were approached to obtain their reactions. The response was overwhelmingly positive. We found that a number of development-oriented organizations have begun to focus on environmental issues. To them ecology means more than just pretty trees, mountains, rivers, animals etc. It also includes natural resources: land, water, air etc. A lot of them have realized that the conflicts in the development processes are essentially conflicts for control of these resources. From that it has only been a short leap to the conclusion that changes in the environment have a direct impact on the lives of the people, particularly the poor, who are dependent on their immediate environment for their basic needs.

The fog was beginning to lift for us; the focus of the report had become sharp — to explain how environmental changes were affecting the lives of the people.

A planning session held on December 30, 1981, which was attended by representatives from some of the cooperating organizations, helped finalize the decision to produce the report. A tentative table of contents and a time schedule were drawn up. A number of people came forward to take responsibility for preparation of specific chapters. It was decided that:

- No grants would be sought. Instead, the entire year's budget of almost Rs 250,000 covering the expenses for researchers, writers, editors, organizers, printing, paper, advertising, postage, would be recovered.
- A hardback institutional edition priced at Rs 125 and a limited cheap edition for voluntary organizations would be published in English by CSE. Pre-publication expenses would be met largely by funds generated by CSE's information service, advance sales of the report, and having a considerate team who could wait to collect what would be owed them.
- Anupam Mishra, on behalf of the Gandhi Peace Foundation's Environment Cell undertook to prepare a Hindi edition of the report. This was exciting — along with the Malayalam version, we could now see the report beginning to reach far beyond the English

medium crowd.

January and February were spent contacting the countless persons who could provide us with the small details of each chapter, buy advance copies and give us new contacts. A whirlwind tour of Gujarat, Maharashtra, Karnataka, Kerala and Goa yielded rich dividends. Parisar, a Pune-based group offered to produce a Marathi edition.

As word of the report spread, offers of assistance in the form of ideas, writing and money began to stream in. Before a single word had been written, a few hundred copies were either paid or pledged for. Some doubts were expressed too: would all the people really write? Could the report really be completed by June 5th? Looking back, some of these doubts were probably warnings of the problems ahead.

The tremendous response inspired us to break fresh ground:

- The Chipko Andolan is perhaps the best known grassroots ecological movement in the country. Yet few persons are well-informed about life in the hill districts of Uttarakhand. Two fresh science graduates of Garhwal University were asked to tour the area, and prepare a regional report.
- Similarly, hardly anyone among us knew much about the northeastern states, ecologically a fascinating and important region. Two Bombay-based journalists, including another one of us — Kalpana Sharma, with excellent contacts in the northeast, agreed to go there and write another regional report. Three weeks on a tight budget produced a goldmine of information.
- By now, the report had gathered a momentum of its own. We needed a professional editor. Kalpana Sharma, back from the northeast, joined the team in Delhi.
- A vital issue emerged from our many conversations: a significant section of India's population exists beyond the pale of the mainstream Indian society. Each time a major development project goes up, or there is a fresh inroad into the remote areas for untapped natural resources, a new ecological niche is destroyed and another lot of these marginal people are uprooted and pauperised. We needed knowledgeable people with a special sensitivity to these groups, to write about their lives. Three anthropologists, a sociologist and two development activists, filed reports that led to a new chapter.
- One author on a visit to Delhi spent a Sunday morning composing his chapter. We reviewed it in the afternoon. Two weeks later, we had the revised version in our hands.

Indeed, the enthusiasm and flow of ideas generated by the report was such that the originally planned 100-page book had to be doubled in size before we were finished. (That is the best excuse we can give for the long delay in publishing the report!)

The readers too are likely to find this report stimulating in many ways:

- For the first time there is a national report which not only provides facts and figures on the levels of pollution, soil loss and destruction of forests, but also presents what these figures spell for the daily lives of the people. People are generally missing from all available national and global reports on the environment.
- Most of us come to know of environmental problems and effects in a piecemeal manner. But when we read this overview of the state of a nation's rivers, dams, forests, air, soil, plants, animals, towns, villages, health and energy problems, the impact is certainly overwhelming.
- The report also provides an overview of the work that is being done by non-governmental and governmental organisations and shows how inadequate and, in many cases, how inappropriate it is.
- Our attempt has been to present the matter in a most readable fashion. The report is well-illustrated and written in a journalistic style without sacrificing either depth or scope.

Information which leads to action is power. With this in mind, we want to achieve as wide a distribution of this report as possible. Our role has been to gather the material into a cohesive whole and turn it into a form which will encourage people to act. The sections on people's groups should be useful. It can put people in touch with one another, thus, assisting in the current efforts to create a much-needed network of environmentalists. The reference section has been prepared in a manner which can help the readers obtain or locate the sources of information. Arrangements have also been made to make available a limited number of copies at a nominal price to unfinanced grassroots groups and individuals.

For information to reach the masses of India's population, whose involvement is essential for any environmental movement, it must be presented in the local language using the local idiom. Grassroots workers are, therefore, encouraged to reshape this material to fit their own situation. We hope necessary alterations will be made by the translating groups.

This report can also become a good tool for researchers to identify gaps in understanding. For instance, though some things are now known about energy consumption patterns in rural areas, there is hardly any information available about the energy consumption patterns of those living in small towns or of the bottom fifty per cent income groups in metropolitan centres. There continues to be a heavy dependence or urban India on firewood. But firewood prices in urban areas are rising faster than food prices. How exactly then, is urban India meeting its basic energy needs? Are urban people becoming the major cause for the destruction of the country's vegetative cover, even more so than the rural people? Is the number of people involved in selling firewood as large as the total number of people employed by the country's organised industrial sector? These and scores of other questions are posed by this report which need urgent answers.

Then there are facts that, for some unexplainable reason, have never found a place in the country's consciousness. For instance, the size of the country's population which is nomadic is almost as large as the tribal population. But few of us have ever thought of our country as being inhabited by millions of nomadic people. With the drastic reduction in and deterioration of pasture lands, these groups are now being totally destroyed. The government has never had any policy to protect pasture lands. We find these nomads, culturally uprooted by a changing environment, finally living

right under our noses — as squalor-stricken urban migrants, working as extremely poor construction labourers in abysmal conditions. Yet the number of social scientists who have studied the nomadic peoples of India can be counted on two hands.

The most striking thing that we learnt during the preparation of the report, and hope that our readers will appreciate too, is that the women of India, who are largely left to fend for the basic material needs of the family, are more concerned about husbanding the environment.

The report, thus, tries to point out to all these important and yet little known facets of our culture, heritage and environment.

This report can be used as recommended reading, as part of the curricula in senior schools and junior colleges. We hope that it will inspire students to initiate environment-related activities. Perhaps some chemist or engineer will design simple and cheap water/air pollution measurement devices. A marriage between these two possibilities could give an enormous boost to community participation in worthwhile development and environmental protection activities. In the absence of any data, even rough measurements which indicate trends accurately are to be welcomed.

As far as possible we have tried to keep the language in the report, non-sexist. Errors that have slipped in are inadvertant and we apologise for them without qualification.

As we have said earlier, this report has been prepared under an enormous pressure of time. We would have liked to check and cross-check every fact and figure but given the size of the country, it was not always possible to do so. Errors in reporting and at times even of understanding, are bound to have crept in. We hope the readers will excuse our lapses, but more importantly, they will take the trouble to point them out to the editors.

In many areas, however, we discovered that large amounts of data are passed around which are wrong. Figures cited by one government department do not match the statistics issued by another. In a few cases, we have tried to show how various guesstimates have been arrived at.

We also want to know from our readers what else we can add in our next report. What are the gaps in the existing report? Which areas need more intensive study? We realise that we have not touched many areas like the dangers of nuclear power, erosion of plant and animal genetic resources, pollution control technology, wetlands conservation, increase in plant pests and diseases, etc. Many others have been dealt with in a very cursory manner. We invite all our readers to tell us what they think we ought to do next. Readers must regard themselves as full members of the network.

In our operations, too, we still have areas in which we can improve our performace. Our planning and punctuality can certainly be improved upon. Less than a fourth of our contributors are women. We will have to make greater efforts to involve more women in the future. People coming from a rural background are again heavily under-represented. We hope that with time we will be able rectify all these shortcomings.

It is our pleasant duty to thank all those who have patiently listened to us go on and on in our excitement about the venture and have given us all the encouragement to go ahead. This has been a most invigorating co-operative effort and we consider the massive participation as being the key factor in this achievement. Every contributor shares the credit for the final product and the editors have been separately identified because they alone bear the responsibility for the mistakes in it.

Anil Agarwal
Ravi Chopra
Kalpana Sharma

LAND

- *Every six months, more topsoil gets washed away than has been used to build all the brick houses across the country.*

- *In the highly-grazed Shivalik hills six cm of top soil, representing nearly 2400 years of local ecological history, often disappears with one monsoon.*

- *Between a quarter to a half of the lands brought under irrigation can go out of cultivation permanently because of soil salinity and waterlogging.*

- *The land area prone to floods has doubled from 20 million hectares to about 40 million in the last ten years.*

- *Intensive agriculture, without supplementation by organic manure, is leading to a rapid depletion of soil fertility. The 1980-81 foodgrain output meant a withdrawal of 18 million tonnes of plant nutrients from the soil but farmers added back only 11 million tonnes.*

- *Ludhiana district in the green revolution state of Punjab, which records the highest yields of many crops, now also records the highest deficiencies of plant micronutrients in its soils.*

1

LAND

In the next 20 years an area equal to the entire cultivated area of India today, that is 140 million hectares, will be lost to the world if soil erosion continues unabated. Nearly five to seven million hectares of good agricultural land are being eroded every year all over the world.

As with other countries, the future of India, or at least of its ability to feed its people, will depend on the health of its soils. By the end of the century, the Indian population is expected to touch almost a billion. This will mean the annual production of at least 230-240 million tonnes of foodgrains as against 130 million tonnes now. The obvious question is: Can we feed such a large population without permanently destroying our lands?

Increased production is now possible only through intensive farming and multiple cropping. The National Commission on Agriculture estimated in 1976 that the net sown area in the country will increase only marginally from 140 million hectares in 1971 to 145 million hectares in 2000. Actually it may even decrease with the relentless growth of urban areas.

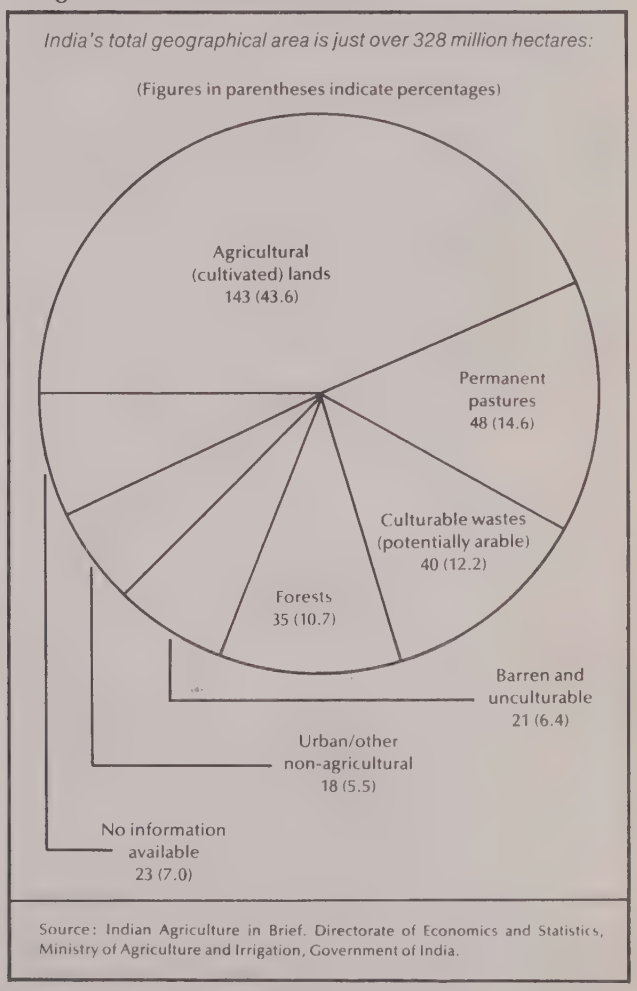
If properly husbanded and nurtured, our soils can produce enough for our people. But neglect could lead to disaster. Soil scientists attending the 12th International Congress of Soil Science in New Delhi in February 1980 were united on a one point charter for the world: Every nation must have a clear, well-identified and implementable national policy to husband its soils. "Save the Oil" remains a far more important slogan for our politicians than "Save the Soil", lamented Dr. J.S. Kanwar, director of research at the International Crops Research Institute for the Semi-Arid Tropics in Hyderabad, even though soils constitute the substratum of civilisation.

Agricultural scientists agree that the country's land, water and sunlight resources do not pose any major limitations in feeding even twice our existing population. Most of our land remains underutilised — unirrigated, single-cropped and low-yielding. The possibility of increasing the country's irrigated area is vast.

India has more unharnessed water resources than most countries in the Third World, especially at a time when worldwide additions to irrigated acreage are slowing down as compared to the past 25 years. According to projections made by the Food and Agriculture Organisation (FAO) of the United Nations, the irrigated area in developing countries is expected to expand from 105 to 148 million hectares between 1980 and 2000, with "three-quarters of this expansion taking place in the Far East, and three-quarters of that in India alone".

In the absence of good water management, Indian yields remain very low. As compared to China, for instance, India had 20 per cent more land under paddy in 1979 but production was 40 per cent less. The average national paddy yields in China are now well over three tonnes per hectare while yields in India have only just touched 1.6 tonnes.

Figure 1. Land utilisation statistics


India's total geographical area is just over 328 million hectares:
(Figures in parentheses indicate percentages)
Agricultural (cultivated) lands 143 (43.6)
Permanent pastures 48 (14.6)
Culturable wastes (potentially arable) 40 (12.2)
Forests 35 (10.7)
Barren and unculturable 21 (6.4)
Urban/other non-agricultural 18 (5.5)
No information available 23 (7.0)

Source: Indian Agriculture in Brief. Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation, Government of India.

Considering the availability of our soil and water resources, there is no reason why India cannot reach a foodgrains output of 300 million tonnes (as compared to the present US output of 250-260 million tonnes). An average yield of four tonnes per hectare from irrigated lands and two tonnes from unirrigated lands should give India a total production of 426 million tonnes of grains in 2000. Assuming

that a part of this land is used for non-grain crops, India should still be able to achieve a target of 350 million tonnes of grains against a requirement of 300 million tonnes for entire South Asia, as projected by the recent US study Global 2000. This is not an unrealistic projection as even available agricultural technology is capable of yielding an average of 10 tonnes per irrigated hectare per year. Certain calculations put the agricultural potential in India at 35 times its present level.

Soils mismanaged

However, in reality, these agricultural dreams may never be achieved. The single biggest threat is the growing mismanagement of our soils. As many as 175 million hectares (constituting 53 per cent of India's total land area) are subject to serious environmental degradation (see Table 2). Of the cultivated area of about 140 million hectares, nearly 60 per cent requires soil conservation measures.

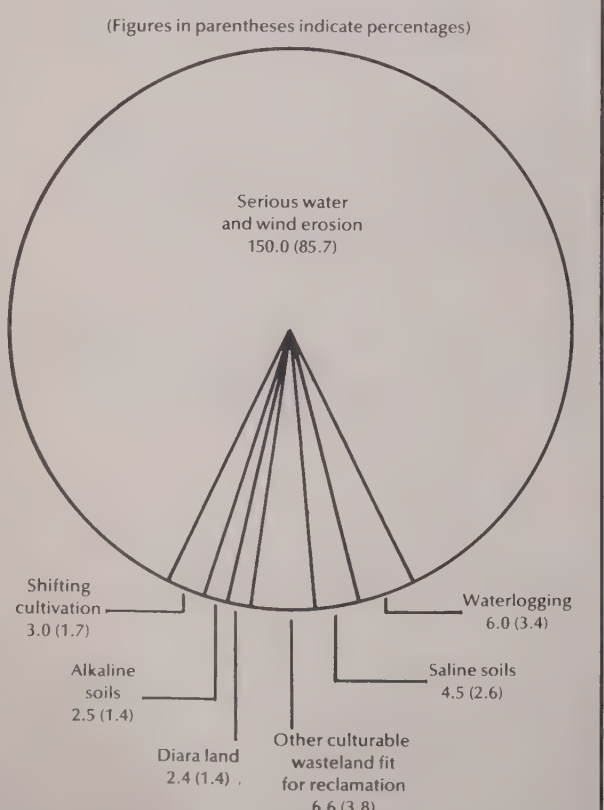
In the Deccan black soil area the top soil loss in a single year is often as high as 40-100 tonnes per hectare. In the highly grazed Shivalik hills, six cms of top soil, representing nearly 2400 years of local ecological history, can disappear in one year. The formation of 1 cm soil *in situ* can take about 500 to 1000 years depending on the nature of the parent material and the intensity of weather. It is extremely difficult to calculate the total national soil loss as a result of erosion, but certain estimates put it at around 6000 million tonnes in 1972, which in terms of the major nutrients, nitrogen, phosphorus and potassium alone represented an annual loss of 5.37 million tonnes priced at Rs 700 crores in that year. The corresponding loss today must be of a much higher order, with fertiliser prices much higher and a greater extent and intensity of erosion. Considering that in 1980 India's fertiliser consumption amounted to 5.5 million tonnes, this means that the country is losing as large a quantity of inorganic fertilisers every year as it is putting in artificially.

According to Dr K.G. Tejwani of the Central Soil and Water Conservation Research and Training Institute (CSWCRTI) at Dehra Dun, one-third of our land under forests, nearly two-thirds under agriculture and nearly all culturable wastelands, permanent pastures and grazing lands are in urgent need of soil conservation measures. If the total losses in agricultural, animal and forestry production could be calculated because of this continuing environmental degradation, they would certainly be several times more than the annual budgets or the Central and State agricultural ministries combined.

Urbanisation is also taking its toll of our precious agricultural land. Not only is land disappearing under concrete buildings and tar roads, but good agricultural land is also being destroyed to produce bricks. It has been estimated that the brick work for a modest house for a family of five in an urban area would require about 120 tonnes of soil. To house the existing urban population alone nearly 3000 million tonnes of soil (mostly top soil) would have to be excavated at one time or the other. Apart from the loss of fertile soil, unplanned excavation, as at present, is also leading to soil erosion and water stagnation which in turn leads to soil salinity.

Figure 2. Land suffering degradation

In 1980 the Ministry of Agriculture published information indicating that 175 million hectares of agricultural and non-agricultural land were suffering degradation from various causes:


(Figures in parentheses indicate percentages)
Serious water and wind erosion 150.0 (85.7)
Shifting cultivation 3.0 (1.7)
Alkaline soils 2.5 (1.4)
Diara land 2.4 (1.4)
Other culturable wasteland fit for reclamation 6.6 (3.8)
Saline soils 4.5 (2.6)
Waterlogging 6.0 (3.4)

Source: Department of Science and Technology, Government of India (1980)

Soil washed away

But such soil loss is small compared to the annual soil loss from erosion. Every six months more soil gets washed away in India than has been used to build all the brick houses from Kashmir to Kanyakumari and Kutch to Kohima. In fact, at the current rate of soil erosion we may be losing this quantity of soil every four to five months.

"It is impossible to overestimate the seriousness of such losses", stresses the Tiwari Committee report which recommended the establishment of a separate department of environment in 1980. The immediate result is increasingly disastrous floods and heavy siltation of the dams built at enormous expense. The large quantity of soil washed away gets lodged in tanks, reservoirs, streams and river beds, reduces their capacity to hold or convey water, and results in heavy floods. It is estimated that the bed of the Ganga has risen by half a metre in the past few years, and the beds of the Terai rivers have also been rising at the rate of 15 to 30 cms per year. However, the long-term effect of soil erosion — a general undermining of the ecological firmament that supports our existence — is even more dangerous.

According to the Report of the National Commission on Floods (1980), in 1976, 1977 and 1978 flood damage was Rs 889 crores, Rs 1200 crores and Rs 1091 crores, respectively, an annual average of over Rs 1000 crores. The report

also reveals that the total area subject to periodic floods, estimated at 20 million hectares in 1971, now stands at 40 million hectares — literally a doubling of the vulnerable area in just 10 years. This is despite the eight million hectares that have been provided flood protection through government programmes at a cost of Rs 347 crores.

The national loss caused by heavy siltation in our 500,000-odd tanks and 487 artificial reservoirs created by major and medium dams, is not easy to calculate. The investment on these dams is over Rs 10,000 crores. A survey of 21 reservoirs published seven years ago revealed that the average annual rate of sedimentation was 8.51 hectare-metres/100 sq km as against the designed inflow of 3.02 hectare-metres/100 sq km. This means that nearly three times more sediment was flowing into these reservoirs than was estimated at the time when they were built, reducing the life of 21 dams on average to a third. Reduction in a reservoir's capacity to hold water diminishes its capacity to hold back heavy flood waters and also reduces the amount of land it can irrigate. According to one calculation, nearly 20 per cent of the live storage capacity of our major and medium dams would be silted up by the end of the century, which would mean a loss of irrigation potential of about four million hectares. In other words, India will continue to lose an irrigation potential of almost 60,000 hectares every year because of siltation.

The Tiwari Committee Report, however, points out that in the case of the big multipurpose projects, what is at stake is not merely irrigation potential. In most cases, alternative sites for building dams are just not available even if the enormous sums of money required to build new dams to replace old ones could be found.

The choking of estuaries and harbours is another adverse impact of eroded soil carried to the sea. Recently, India hoisted its flag on Purbhasa, a new two square kilometre island that has just emerged in the Bay of Bengal. The land mass that is actually emerging is 24 km wide and 11 km long and is the accumulation of all the silt that is brought down by the mighty Ganga and Brahmaputra. The island is, in fact, the accumulated result of our own environmental mismanagement.

Costly conservation

The Sixth Plan has proposed soil conservation programmes to cover 6.4 million hectares of land at a cost of Rs 585 crores. If with every future plan, the land to be covered by conservation measures was increased by 3.5 million hectares, Tejwani of CSWCRTI estimates that by the end of the Tenth Five Year Plan (1999-2004) some 90 million hectares would have been treated. The total cost would be Rs 6677 crores, assuming that future conservation costs will remain similar to those in the Sixth Plan.

"These projections do not take into account the cost of maintaining or rebuilding the works, the life of which is generally estimated to be 15 years under field conditions", says Tejwani. "Reclamation of saline and alkali lands has been initiated in the country with useful results, but large-scale land reclamation programmes for saline and alkali lands, solving the problems of shifting cultivation, desert afforestation and stabilisation are yet to be initiated. If projects for these are undertaken, the amounts needed will be staggering." Meanwhile soil conservation has yet to become a major policy issue for the country.

But the radical suggestion that Mr B.B. Vohra, Chairman of the National Committee on Environmental Planning, made in his now famous Sardar Patel Memorial Lectures of 1980, that the cultivated area of about 140 million hectares should be reduced to 100 million hectares, has been criticised on the ground that it will create massive and unmanageable unemployment. Vohra argued in his lectures that under proper management, 100 million hectares of good agricultural land yields upwards of 300 million tonnes of foodgrains per year — "a quantity which will be sufficient to maintain a population of 1000 million at higher nutritional levels than we can boast of today". Therefore, the nation will not lose economically by reverting the remaining land degraded but still under cultivation, to non-agricultural uses like forestry.

In an article in "Mainstream", Sekhar Singh, a lecturer at the Indian Institute of Public Administration, points out that such poor lands invariably support small and marginal farmers. Some of these lands are directly owned by them while most of the rest of the degraded land has been leased out to them by rich landlords. It is these small and marginal farmers who would become landless, if Vohra's suggestion was implemented. "Converting these implications into numbers is not easy," says Sekhar Singh, "mainly because no accurate figures seem to be available either of size of individual holdings in terms of quality of land, or of proportion of land leased out or cultivated by wage labour in terms of land quality." But using available figures, Singh estimates that the 40 million hectares that Vohra suggests should go to non-agricultural uses, must have been supporting a population of 225 million in 1971 and some 280 million in 1981.

Moreover, most of the land would have to be retired from agriculture in areas where the demand for rural labour is low. For example, large amounts of land would have to be reverted to non-agricultural use in Bihar and Orissa, while the demand for rural labour exists in Punjab and Haryana. "This would create a very large class of migrant, almost nomadic, labour with all the attendant problems", says Singh. It is also unlikely that soil conservation programmes, however large, could absorb all the labour generated by Vohra's policy suggestion — at best a seventh of those displaced from their lands, according to Singh's calculation. Singh himself argues that Vohra's suggestion can be implemented either by bringing about nationwide land reforms so that reversion of poor land to non-agricultural uses does not displace a large number of people, or through an industrial policy which does not allow capital intensification at the cost of employment so that people can rapidly find employment in industry.

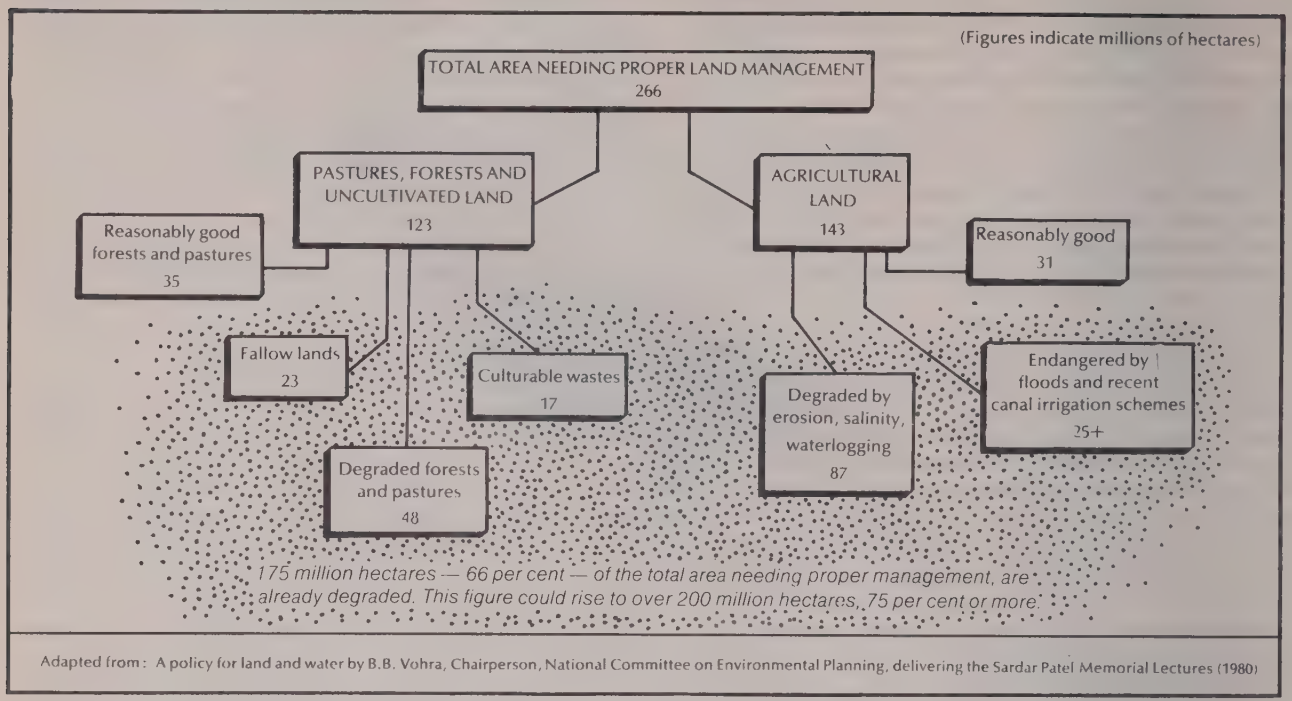
Clearly, there is a need for a national debate on how India's lands ought to be managed. The earlier this debate takes place the better. As Vohra puts it: "Perhaps 20 years is the utmost that we can allow ourselves .... what we are engaged in is basically a race against time".

Soil salinity

Irrigation canals bring farmers the most important input for increased agricultural production. But they also have the potential to turn green fields into waterlogged and saline wastelands.

Over Rs 10,000 crores have been spent in developing surface and groundwater irrigation systems in this country

Figure 3. Estimates of land that is wasted, under-utilised and endangered


(Figures indicate millions of hectares)
TOTAL AREA NEEDING PROPER LAND MANAGEMENT
266
PASTURES, FORESTS AND UNCULTIVATED LAND
123
AGRICULTURAL LAND
143
Reasonably good forests and pastures
35
Reasonably good
31
Fallow lands
23
Culturable wastes
17
Degraded forests and pastures
48
Degraded by erosion, salinity, waterlogging
87
Endangered by floods and recent canal irrigation schemes
25+
175 million hectares — 66 per cent — of the total area needing proper management, are already degraded. This figure could rise to over 200 million hectares, 75 per cent or more.

Adapted from: A policy for land and water by B.B. Vohra, Chairperson, National Committee on Environmental Planning, delivering the Sardar Patel Memorial Lectures (1980)

during the last 30 years. Another Rs 10,000 crores have been allocated for irrigation development during the Sixth Plan (1980-85), making it probably the largest irrigation development programme in the world today. An additional 13.7 million hectares will be brought under irrigation during these five years — today 40 million hectares are irrigated.

These facilities have indeed played a major role in increasing our agricultural production. It has been estimated that 75 per cent of the annual increase in foodgrain production during the 1960s and 70s came from increases in yields, and only 25 per cent from increases in cultivated area. High yielding varieties have played an important role in increasing crop yields but they have been successful mainly in areas with assured water supplies, that is, where irrigation facilities exist. By the end of the century the Government hopes that over 70 million hectares will be under irrigation.

Irrigation: blessing or bane

However "irrigation has not been an unmixed blessing", points out senior agricultural scientist Dr M.S. Swaminathan in a paper entitled "Indian Agriculture at the Crossroads". In a number of irrigation projects, salinity and waterlogging have appeared within a few years of the introduction of irrigation. This has harmed many farmers more than it has benefitted them.

Lands in canal areas are often flat and poorly drained. The application of irrigation water to them results in waterlogging and salinity over a period of time. This process of waterlogging and salinity has been hastened in many parts of India because of several circumstances. First, the application of canal water to crops has often been far in excess of their needs. There are few installations and field channels to regulate the flow of water to individual fields. Secondly, canals and distributaries are usually not lined and they contribute to waterlogging through seepage. In some surface irrigation systems as much as 40 per cent of the water released from the reservoir can be lost because of seepage.

Nearly seven million hectares of land have already gone out of production because of severe salinity and an additional six million hectares of lands are lying seriously affected by waterlogging. According to B.B. Vohra, of these 13 million hectares "perhaps half are situated in estuarine and coastal areas and have not been productive in recent times. However, at least six million hectares comprise lands which were productive till the other day, so to say, and have been lost to waterlogging and salinity on account of man-made situations".

One important cause of waterlogging is neglect of drainage while building engineering works such as flood control embankments and road, rail and canal embankments. "If, as is often the case, such embankments do not contain adequate cross-drainage works, water gets held against them and causes damage to the areas submerged," says Vohra. "The answer to such situations, though expensive, is fairly easy — it lies in the construction of adequate cross-drainage works wherever these are required."

Waterlogging

However, it is the second cause — the spread of canal irrigation — that is much more alarming. According to Vohra, no precise estimates of areas threatened by waterlogging and salinity are available but from the experience of India and other countries with extensive canal irrigated areas. "It would not be unreasonable to assume that at least 10 million hectares of our total irrigated area of around 40 million hectares are threatened by waterlogging and salinity and are in urgent need of attention if they are not to go out of

production in the near future."

Of the 40 million hectares irrigated in India, about one half are irrigated by surface systems like canals and tanks and the other half by ground water systems like open dug wells and tubewells. Vohra's estimates, therefore, imply that nearly half the area in the country served by surface irrigation works is threatened by waterlogging and salinity. Very high priority, therefore, has to be given to save these lands.

According to Dr M.S. Swaminathan, within 10 years of the introduction of canal irrigation in the Chambal area in Rajasthan and Madhya Pradesh, about 25 per cent of the command area became waterlogged. Similar problems have emerged in other command areas, particularly in the black soil region. Studies in the Bhakra canal command area have shown that within 10 years the water table there rose by about eight metres. The drainage problem is acute in Punjab and Haryana and it also exists in various irrigation projects in UP, West Bengal, Gujarat, Madhya Pradesh and Maharashtra.

Though precise data on the extent of waterlogged areas in the country is not available, the National Commission on Agriculture had estimated in 1976 that of the six million hectares that is waterlogged some 3.4 million hectares are subject to surface flooding (mostly in the states of West Bengal, Orissa, Andhra Pradesh Gujarat, Punjab, UP, Tamil Nadu and Kerala) and some 2.6 million hectares are waterlogged because of a high water table. Precise statistics on the extent of waterlogged areas in various States have yet to be compiled.

Amongst the post-independence major irrigation projects where serious waterlogging and salinity problems or problems of inadequate drainage have arisen, the most notable are the Chambal Project in MP and Rajasthan, Kosi and Gandak projects in Bihar, Nagarjunasagar in Andhra Pradesh, Kakrapar in Gujarat, Purna, Pravara and Neera projects in Maharashtra, Dantiwada in Gujarat, Barna and Tawa in Madhya Pradesh, Lower Ganga Canal in UP, Malampuzha in Kerala, Periyar-Vaigai in Tamil Nadu, Tungabhadra in Andhra Pradesh and Karnataka, Sone system in Bihar, Ranbir and Pratapa Canals in Jammu and Kashmir, Jamuna in Assam, Hirakud and Mahanadi Delta in Orissa and Krishna Delta in Andhra Pradesh.

Salinity

A major portion of the salt affected lands lie in the otherwise fertile Indo-Gangetic plains of Punjab, Haryana and UP. The other areas having problems of salinity and alkalinity are the semi-arid areas of the medium and deep black soils of Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Gujarat, the deltaic coastal areas of West Bengal, Orissa and Gujarat, and, the irrigated areas of Rajasthan and Gujarat. The threat of this type of soil degradation is particularly serious in the deep and medium black cotton soils of India, which are coming under new irrigation projects. The nature and amount of clay and lack of underground drainage makes these soils vulnerable to the sodium hazard. Black cotton soils of the Deccan are a major resource for agriculture in India. They span over vast areas of the peninsula from Gwalior in the north to Raichur in the South, extending through six states.

Arid and semi-arid areas brought under irrigation are also affected by increased salinity because of the rising groundwater table. The Thar desert has a number of canals and with the completion of the Rajasthan Canal Project, about 11 per cent of Western Rajasthan will be under irrigation. In the Anupgarh Shakha area, the water table is rising at an average rate of 1.52 metres per year and at places the rate is as high as three metres. In the Ghaggar flood area, the water table has risen by six to nine metres.

In many parts of the Thar desert rainwater for subsequent irrigation is collected in village ponds which have been constructed with the help of small dams. These efforts too have resulted in the deterioration of the desert ecosystem, says Dr H.S. Mann of the Central Arid Zone Research Institute in Jodhpur. In the small Luni development block, for instance, before 1958 only an area of 8.3 sq km of land was salinised beyond use. But with the construction of tanks, salinity has spread laterally within this block and now affects an additional area of 15.6 sq kms. If the existing situation continues, another 40 sq kms will be affected.

Table 1. Areas of salinity

Broad group	States in which found	Approximate area (million ha))
Coastal salt-affected soils		
In arid regions	Gujarat	0.714
In deltaic and humid regions	West Bengal, Orissa, Andhra Pradesh, Tamil Nadu	1.394
Acid soils	Kerala	0.016
Salt-affected soils of the medium and deep black soil regions	Karnataka, Madhya Pradesh, Andhra Pradesh, Maharashtra	1.420
Salt-affected soils of the arid and semi-arid regions	Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh	1.000
Sodic soils of the Indo-Gangetic plain	Haryana, Punjab, Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh	2.500
	Total	7.044

Source: D.R. Bhumbla (1977), Central Soil Salinity Research Institute, Karnal.

Poor drainage

In Haryana and UP — Karnal and Deoria districts, for instance — a number of government tubewells have been installed on the banks of canals to lower the groundwater table. If the cost of these tubewells had been added to initial project estimates, these projects may not have been able to meet the Planning Commission's minimum cost-benefit criteria and would, therefore, have been rejected. In many areas, the groundwater itself is saline and cannot be used for irrigation. In such circumstances, even the installation of tubewells does not provide a remedy.

Such areas should be studied closely for their drainage needs and those which are in imminent danger of water logging and salinisation should be quickly taken up for treatment, argues Vohra. These 10 million odd hectares of newly irrigated lands would require a huge outlay, he says, perhaps not less than Rs 10,000 per hectare on an average or Rs 10,000 crore for the total area.

Apart from the lining of canals and distributaries which is important, field channels and drains will have to be designed and built not on the basis of individual holdings

but on the scientific basis of natural drainage units. Such works will call for detailed planning and careful execution. Past experience has shown that in most cases the levelling and reshaping of command areas will also be necessary before proper water distribution and drainage systems can be built. This will, in turn, require consolidation of land holdings and redrawing of field boundaries.

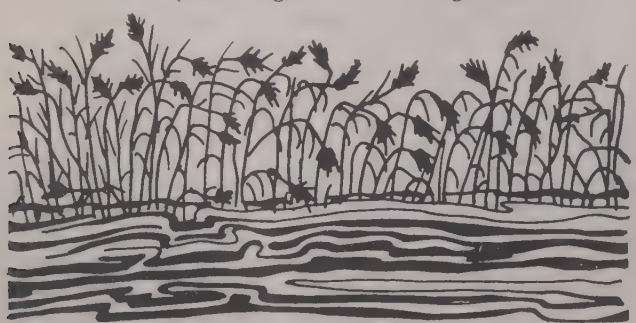
In fact, the bulk of our canals are not served by field channels. Instead a primitive method of passing water from one field to the other is used. In such circumstances crops receive more water than they need, fertiliser use is low, yields are poor and waterlogging sets in rapidly. Although field to field irrigation is suitable for certain kharif crops, it is unfit for most rabi crops. Therefore double-cropping in even canal irrigated areas of India is rare and average yields in irrigated areas are only about 1.7 tonnes of foodgrains per hectare. In other countries yields of four to five tonnes per hectare from irrigated areas are not uncommon.

The neglect of drainage facilities when building gigantic irrigation schemes is indeed appalling. In 1929, the report of the Royal Commission of Agriculture in India had stated: "It would appear that many of the troubles which have arisen in the irrigated tracts of India in regard to waterlogging and formation of salty land have been due to failure to properly correlate a new irrigation system with the natural drainage of the tract." The commission recommended drainage construction in all new irrigation projects. In 1982 scientists like J.S. Kanwar and M.S. Swaminathan and officials like B.B. Vohra are still pointing out the same.

"It is important that we stop looking upon irrigation projects as feats of engineering. They should be regarded as means of conserving and efficiently using water, which is what they actually are. They must, therefore, be seen in their total ecological context," says Kanwar. Few irrigation projects have been constructed in consultation with soil scientists.

Land fragmentation and differences in cropping management have also helped in the spread of salinity. Differences in cropping patterns and irrigation levels between adjacent farmers can spread salinity by creating the right conditions for salts to migrate from high to low spots, from crop areas with more frequent irrigation to those with less frequency, and from wet soils to relatively dry soils.

Similarly the land tenure system can also play an important role in the spread of salinity, according to Dr I.P. Abrol, director of the Central Soil Salinity Research Institute in Karnal. Abrol points out that "many cultivators in India are share-croppers who are often moved around by the landlords to different plots each year. As a results, they have little interest in protecting the soil from degradation"



Reclamation

The Karnal Institute has developed several techniques for reclamation of saline soils. A technique based on the use of fertilisers, gypsum and specific high yielding varieties of rice and wheat, has been effective on the alkaline soils of the Indo-Gangetic plain. The Institute's experience shows that 2.5 million hectares of such deteriorated soils can be made to produce seven to eight tonnes per hectare of rice and wheat annually from the third year of reclamation. To reclaim these soils the Karnal Institute recommends adding two to 15 tonnes per hectare of gypsum depending on the condition of the soil. This can improve the top 15 cms of the soil which is sufficient if a proper choice of crop is made. Application of gypsum with adequate and appropriate irrigation and fertilisation helps in pushing down the sodium salts deeper into the soil.

In the past three to four years, nearly 100,000 hectares of saline soils have been brought under cultivation in the states of Haryana, Punjab and UP. Programmes are underway to take up reclamation work covering about 100,000 additional hectares each year in these states. "If accomplished these programmes would mean an additional one million hectares under cultivation, which will produce five million tonnes of foodgrains annually", says Abrol. The Karnal Institute unfortunately has just one branch in West Bengal, even though large tracts of saline lands exist in Karnataka, Madhya Pradesh, Andhra Pradesh, Orrisa, Tamil Nadu, Gujarat, Kerala and Bihar where no reclamation work is being undertaken.

The Biomass Research Centres recently set up by the Department of Science and Technology are simultaneously trying to find trees which can grow on saline soils. This would help to increase fuelwood and timber supplies. Modern technology should, therefore, soon be able to offer many alternatives for the use of such lands.

Increasing inequalities

However unless promoted within a proper policy framework, some of these techniques may lead to political problems like increasing inequalities in landholdings. The Karnal Institute has faced difficulties in explaining complicated reclamation techniques to small, illiterate farmers. These farmers usually have no alternative to selling their lands, once they are salinised, to rich farmers who alone have enough capital to invest in reclaiming these lands. The poor farmers become landless labourers in the same village or migrate to the towns. Ranjit Singh, for instance, is an enterprising farmer who once owned 35 acres of land in Ferozepur, Punjab. He sold this land at Rs 12,000 per acre some five years ago and bought 50 acres of barren saline land instead in Karnal at Rs 500 per acre. The money he saved in the process was invested in reclaiming this new land. Today Singh proudly shows his fertile fields worth Rs 20,000 per acre. He has, thus, more than doubled his wealth. However nobody knows what has happened to the farmer who sold his land to Singh. Those cultivating the saline lands in Karnal today are mostly outsiders, usually government officials and rich farmers from Punjab.

In the Tawa irrigation project in Madhya Pradesh too, many low lying farmlands have become waterlogged while the rich farmers have installed tubewells to lower the

Mitti Bachao and Tawa dam

Dry land plus irrigation equals luxuriant crops and prosperity for the farmer — this belief dictated the policy of building large irrigation projects. But recent studies have shown that more often than not such large irrigation projects reduce the fertility of the soil by causing waterlogging and salinity and subsequently decrease crop production.

This has been the experience of the over one lakh farmers of Hoshangabad district in Madhya Pradesh, the supposed beneficiaries of the Rs 91.42 crore Tawa dam, which is a part of the Rs 300 crore integrated irrigation scheme on the Narmada river. A dam is being built on the confluence of the Tawa, a major tributary of the Narmada, and the Denva, another tributary.

The farmers of the area launched a unique Save the Soil Campaign — Mitti Bachao Abhiyan — in August 1977; their long-standing experience of cultivating the heavy retentive black cotton soil told them that the canal and the irrigation project would spell disaster for the area. The spark that led to the agitation was the government charging the farmers excessive amounts for landshaping, a process needed to facilitate irrigation. After an initial promise that landshaping charges would not exceed Rs 1100, the actual charges went up as high as Rs 6500; 125 farmers were overcharged a total amount of Rs 11 lakhs for landshaping.

Further, the soil became increasingly waterlogged. Black cotton soil is water retentive; excessive surface water results in the rise of sub-soil water which reaches the root zone of the crops. Harmful salts move upwards in the soil along with the water. In time the land loses its productivity.

Water seepage in such soil was foreseen but its extent was underestimated. Project authorities thought it would be only 30 per cent through the unlined canals; later surveys showed that it was as much as 60 per cent. The most productive areas before the advent of irrigation have now been affected by water seepage.

Traditionally the one lakh farmers of the region practised dry farming. The water table is fairly high and therefore suited to tubewell irrigation. The district also has a high average rainfall — 1303 mm. In the Kharif season the farmers grew jowar, sesame and cotton and in the Rabi, wheat. This crop rotation plus compost and manure met the deficiencies in the soil.

With canal water flooding the fields, traditional varieties of wheat cannot grow any more; also pulses and sesame have gone out of production. They have been replaced by soyabean which is supplied to a nearby factory for soyabean-based products. But the change in crop patterns is also replacing self-sufficiency with dependence. Soyabean has to be harvested at short intervals; instead of doing this themselves the farmers have begun to hire tribal labour from neighbouring villages. Seed banks provide the high-yielding seeds but these varieties also require fertilizer and pesticides. The margin of profit on soyabean is many times lower than what the farmer earned from pulses.

Further, recent surveys have shown a clear drop in the productivity of the irrigated waterlogged soil. According to the report of the Auditor General of India (1979-80) on the Tawa project, whereas paddy production before irrigation was averaging four quintals per acre, after irrigation it has dropped to 3.88 quintals. A similar perceptible drop is seen in the production of jowar, maize wheat and gram. The Auditor General concluded in his report that "the project was ill-conceived and benefits that were presumed would be available could not have been realised". He suggested a second look at the programme.

This much needed second look has not yet been forthcoming. The Mitti Bachao campaign continues; although the farmers accept that the project is now a *fait accompli*, they are still fighting for ways to modify it so that the damage is minimised. For instance, they are planting trees in the waterlogged areas to absorb excess water. They are also waiting for the Government to recompense them for the amounts overcharged for landshaping. Some local rural development groups, however, disagree with the extent of land affected by seepage and the class character of the farmers affected. Therefore they have hesitated to give unconditional support to the Mitti Bachao campaign.

The Tawa experience underlines again the hazards of big irrigation projects conceived without taking into account the impact on soil fertility. B.B. Vohra, Chairperson, National Committee on Environmental Planning says that almost half the world's irrigated land is damaged to some degree by waterlogging and salinity. He says:

"Ground irrigation is far more economical than canal irrigation because it does not call for any expenditure on storage and transport. It does not involve loss through submergence of large areas of valuable land under reservoirs or the disturbance of ecological balance as is caused by big irrigation projects". The untapped potential of ground water as estimated today is enough to irrigate another 20 million hectares. If irrigation departments did not have a "pathological preoccupation with big projects", as Vohra puts it, costly mistakes like the Tawa dam could have been avoided.

groundwater table. The small farmers have started selling their lands at very cheap rates becoming landless labourers in the process. Some farmers in Madhya Pradesh, whose lands have been ruined by waterlogging, have started clamouring for compensation (see box).

There is a need for an "integrated monitoring mechanism" on the positive and negative aspects of irrigation projects, in Swaminathan's view. Vohra argues also for a policy favouring groundwater development over surface water systems. Gestation periods of groundwater systems are short compared to large dams; they do not submerge large areas of valuable lands; they do not require costly and complicated systems of water distribution and drainage; farmers tend to be abstemious in the use of ground water as they themselves have to pay the cost of pumping; they do not place the farmer under the control of a huge and often corrupt bureaucracy to get water in time for the cropping season; and these are no losses through evaporation or seepage.

The untapped potential of groundwater as estimated today is enough to irrigate another 20 million hectares. "However, this is undoubtedly an underestimate because there is great scope for the augmentation of groundwater resources as a result of the soil conservation measures which have to be taken up in any case in catchment areas," says Vohra. Groundwater irrigation would be useful even in command areas of canals to keep the water table down and avoid waterlogging.

Soil infertility

After water, chemical fertilisers constitute the next most vital input for modern agriculture. Indian soils are generally poor in plant nutrients. But depending exclusively on chemical fertilisers for providing the necessary nutrients to plants can be dangerous for the fertility of the country's soils in the long run.

According to a map of the nitrogen status of Indian soils, prepared on the basis of 9.2 million soil samples collected from 365 districts and tested by 250 different soil testing laboratories, soils of only 18 districts in the hill regions of north-eastern India and Himachal Pradesh are high in available nitrogen. Soils of 228 districts are low in nitrogen

Productive fields near the Tawa dam (MP) have been ruined by water-logging. (Gandhi Peace Foundation/Anupam Mishra)

and 119 medium. Another report on the availability of phosphorus in our soils points out that 46 per cent of the districts surveyed are low and another 52 per cent medium. An analysis of 4.5 million soil samples collected from 310 districts from 1968 to 1974 shows that the available potassium is also low in 20 per cent of our soils and medium in 42 per cent.

Nutrients lost

During 1980-81, some 5.5 million tonnes of nitrogen, phosphorus and potassium (N, P and K) were used in India and about 130 million tonnes of foodgrains were produced. Dr J.S. Kanwar calculates this quantity of foodgrains resulted in the removal of 18 million tonnes of nutrients from the soil. It can be estimated that some five million tonnes of nutrients were replenished through organic sources. But as only 5.5 million tonnes were put into the soil through chemical fertilisers, this leaves a gap of 7.5 million tonnes of nutrients not added back to the soil.

In addition to this annual drawdown on soil nutrients, India is annually losing another 8.4 million tonnes of N, P and K through water erosion.

Plants do not just take up N, P and K from the soil. They also take up secondary nutrients like calcium, magnesium and sulphur and micronutrients like manganese, iron, copper, zinc, boron and molybdenum, which are essential for healthy plant growth even if required in very small quantities. A rice-wheat rotation producing 8.8 tonnes per hectare per year, besides removing 663 kg of N, P and K, also removes several kilograms of micronutrients. Because micronutrients are not being added artificially — few of our farmers could ever afford them — their deficiency is becoming severe in intensively cropped areas and this deficiency will grow with time.

Fifteen years ago zinc deficiency became prominent in Punjab. Today, manganese and iron deficiencies are also evident. In India as a whole 47 per cent of the soil has become deficient in zinc, five per cent in manganese, 11 per cent in iron. A greater incidence of micronutrient deficiency is recorded from States which have large irrigated areas, intensive cropping and harvest higher yields. Ludhiana district, which records the highest yields of many, also records the highest deficiencies of micronutrients. Calcium and manganese deficiencies are common in acid soils which cover about 30 per cent of the total area in India. Most areas under intensive cultivation are also deficient in sulphur.

Intensive cropping and high yields are only possible through balanced fertiliser use, to maintain higher productivity, says Kanwar. "A tribal farmer practising shifting cultivation and a modern farmer engaged in intensive farming and settled agriculture are both committing the same crime of depleting soil fertility. In the former instance, the tribal society places some restriction though the system is changing fast because of growing population pressure and increasing intensity of land use. But in the latter case the farmer is free of all social restrictions even though in the long term society does have to pay the price", he says. But this cannot go on for long.

Scientists estimate that in a newly deforested area in a tropical region, organic matter is lost at the rate of 20 to 60 per cent per annum even without trying. The presence of organic matter in the soil is vital for good water retention and growth of microflora. Both in turn affect the growth of crops. Good water retention also reduces soil erosion. The alluvium of the Indo-Gangetic plain is generally poor in organic matter and therefore needs to be carefully husbanded. This rapid decline in soil nutrients must be arrested and a proper balance restored if our lands have to double foodgrain production.

If care is not taken our so-called high yielding varieties (HYV) will cease to be high-yielding. Data from the All India Coordinated Wheat Trials shows that new HYVs between 1970 and 1975 would touch annually a mean yield of 6.5 tonnes per hectare. Individual varieties would touch 7.5 tonnes per hectare. In recent year, however, mean yields have been around 5.5 tonnes and maximum individual yields between 6 to 6.5 tonnes — prompting one agricultural scientist to remark that "apparently we are learning to breed for reduced yields".

Organic manure use

However long term experiments in temperate regions and in India indicate that with balanced manuring under intensive cropping, soil fertility can be built up rather than depleted, argues Kanwar. Extensive use of organic manure is the only way to face up to the micronutrient problem.

Unfortunately little attention is being paid to organic wastes and recycling of crop residues. One reason for their neglect may be that government subsidies given to chemical fertilisers are so readily available to farmers that, together with scientists and administrators, they are tending to underplay the importance of organic manures and plant residues. But a major reason is also the lack of cooking energy in the villages. Consequently people are burning cowdung and agricultural residues instead of returning them to the soil. About five million tonnes of rice straw are being burnt uselessly every year from October to December in Punjab, the leading state in the green revolution. Thus in India, soil and precious nutrients not only go down the river but also up into the air as smoke. If only crop residues were ploughed back into the soil, the rate of micronutrient depletion would be substantially reduced.

Besides the loss of valuable nutrients and organic materials that are urgently needed for soil improvement, this burning is also causing air pollution. The bulk of human excreta does go back to the soil, but more in a manner that creates disease instead of enriching soil fertility.

While all these resources go waste, the government of India is subsidising chemical fertilisers. During the current

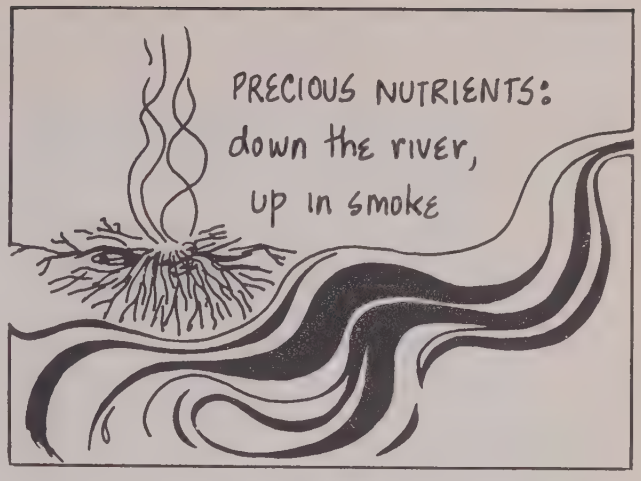
year, food and fertiliser subsidies amounted to 64 per cent of all government subsidies. Fertiliser consumption in India has increased almost seven times in the last 10 years but foodgrain production has not even doubled.

A disturbing aspect of this problem of supplying adequate plant nutrients is that the cost of chemical fertilisers is rising rapidly because of increasing oil prices. Consequently the cost of foodgrain production is rising faster than the purchasing power of the people. This situation obviously has to be corrected soon or it can spell disaster for government finances and economic development plans.

It is universally agreed that the role of organic matter in maximising crop yields has to be emphasised once again but unfortunately precious little is being done about it. Not only can organic wastes help to replace expensive chemical fertilisers, but they also have a beneficial impact on the soil. Studies have repeatedly shown that crop yields are higher when chemical fertilisers have been used to supplement applications of organic manures and crop residues as compared to situations in which chemical fertilisers have been exclusively used. Organic manures have a direct effect on soil fertility, as they are valuable sources of both major and micro nutrients. They also improve soil fertility and properties indirectly by improving the soil structure and by changing its physical properties like water-holding capacity (thereby reducing soil erosion), porosity and hydraulic conductivity. Organic manure also increases microbiological activity in the soil, which often has a beneficial effect on crop yields.

Studies carried out in India show that organic manure can play an important role in increasing yields of many crops such as coarse grains, millets, pulses, oilseeds, sugarcane, etc. If organised properly, India should have no dearth of organic manure. According to estimates made by the National Council of Applied Economic Research (NCAER), 1935 million tonnes of wet cowdung is produced annually in India, of which only about 445 million tonnes (less than 25 per cent) is used for making manure. If the entire quantity of cowdung was used for making manure, it should give about 2.7 million tonnes of N, 1.3 million tonnes of P, and 2.0 million tonnes of K. About 15 million tonnes of urban waste could be composted per year. Poultry litter can annually yield another 0.3, 0.3 and 1.4 million tonnes of N, P and K, respectively. Taking the population of sheep and goats at about 40 and 60 million, their dung can yield 1.0, 0.5 and 0.9 million tonnes of N, P and K, respectively. Sewage and sullage available from the big cities in India could annually yield 33,000 tonnes of N, 7000 tonnes of P and 20,000 tonnes of K.

Besides these, large quantities of slaughter-house wastes, bonemeal, fish-meal, guano, etc are available. Farm crop wastes include sugarcane trash, stubble of millet crops, straw of wheat, rice, sorghum, bajra, etc. These are sources of organic materials which can be profitably utilised for manurial purposes and for improving soil fertility and characteristics. The plant nutrients available from these waste materials will account for 5.6 million tonnes of N, 2.3 million tonnes of P and 10.7 million tonnes of K — far more than the current use of artificial fertilisers. It is, therefore, urgent that practical systems be devised to utilise rural and urban organic wastes wherever possible. This area has been neglected too long.



Though hitherto neglected, integrated nutrient supplies will have to become an important component of India's emerging agricultural technology in the near future, admits Dr M.S. Swaminathan. Nutrient balance sheets ought to be prepared for every village, which take into account the crop yields in the village and the nutrients they are removing from the soil, argues Swaminathan. Assessments would then have to be made of the local availability of organic manure and possiblities for biological nitrogen fixation to compensate for the nutrient loss taking place in the village. Finally, an integrated strategy would have to be developed for the use of organic manures, including green manuring, with chemical fertilisers in a manner that can help to achieve food production targets and maintain soil fertility.

But to develop systems for such integrated nutrient supplies will mean programmes for mass education and mobilising people at the grassroots. The question is: Can any bureaucracy successfully undertake such a decentralised programme?

Alternative to chemical fertilisers

Nitrogen is the most important crop nutrient for increasing food and fibre production. But it is not necessary that this input must come in only through artificial means.

Traditional techniques of multiple cropping and intercropping to maintain soil fertility have much to teach on this subject. The quantities of nitrogen that leguminous plants can fix is vast — food legumes from 40 to over 550 kgs of nitrogen per hectare and forage legumes from 95 to 800 kg.

Some 30 to 35 per cent of the total nitrogen fixed in the world is actually being fixed by agriculturally important legumes. Crop rotations involving a legume to harness this potential can be worked out for most ecological zones. At ICRISAT, millet yields grown after a crop of groundnuts recorded a 23 per cent increase over millet yields when grown after another crop of millet. Similarly, millet yields increased by 20 per cent when grown after a crop of cowpeas.

Traditional Methods

Cereal crops can be combined with nitrogen-fixers and grown together. For instance, maize and beans can be grown in association, raising yields of both. "Alley

cropping" involves planting food crops between rows of leguminous trees such as leucaena, which are pruned in the growing season to provide poles for building houses and wood for burning, while their leaves are laid on the soil as green mulch. Maize grown by this system has yielded 3.5 tonnes per hectare in the second season on a poor African soil with no fertiliser, compared with typical yields of under a tonne.

"Some traditional practises need only be spread wider", recommends "Agriculture: Toward 2000", a major FAO document on world agricultural trends. But much will have to be done to prepare appropriate public policies and technical packages suitable for different ecological and economic situations before the use of organic fertilisers will spread among farmers on a significant scale.

Introduction of crop rotations involving legumes, for instance, is not easy in areas where land is scarce and high-yielding varieties of cereals like wheat are squeezing land away from them. Even though pulses constitute a vital source of protein in the Indian diet, their production has remained more or less static over the last 20 years. Grain legume yields are usually much lower than cereal yields and therefore farmers do not find it profitable to grow them once they get assured irrigation and high-yielding varieties of cereals. The stagnation in pulse production presents a serious threat both to soil fertility and Indian nutrition. Competition of land for food does not permit the growing of forage legumes on a large scale either.

Because of the enormous uncertainties in the existing situation, the FAO document "Agriculture: Toward 2000" admits: "The present and potential uses of organic fertilisers are poorly known, and growth rates in the next two decades cannot be safely predicted. The scenarios until 2000 implicitly (and perhaps optimistically) assume that their share in the increasing total use of fertilisers remains constant."

The "nitrogen enigma"

Meanwhile, scientific research on biological nitrogen fixation is also growing rapidly. The increased cost of nitrogen fertilisers following the oil crisis has spurred on a major effort in this direction.

Many soils that have been continuously cultivated have maintained their nitrogen reserves for centuries. Soils in the semi-arid tropics, for instance, are low in nitrogen and yet they continue to produce 95 per cent of the world's millets and 60 per cent of the world's sorghum with virtually no addition of chemical fertilisers. Most farmers in these regions are in any case too poor to afford fertilisers. Clearly an equilibrium level of soil nitrogen is being maintained through some kind of biological nitrogen fixation.

In a bid to solve this so-called "nitrogen enigma", scientists should be able to find many natural alternatives to chemical fertilisers. Latest research shows that apart from nitrogen-fixing blue-green algae, there are certain bacteria associated with the root systems of sorghum, millets and some tropical grasses which can also fix nitrogen. Blue-green algae can fix as much as 70 kg of nitrogen per hectare per year but levels of 20 to 30 kg per hectare per crop are more commonly observed. Indian scientists have demonstrated the beneficial effects of algal inoculation on the yields of rice and efforts have been made to promote the use of blue-green algae amongst farmers of Tamil Nadu and Uttar Pradesh.

Although scientific attention to these processes of biological nitrogen fixation is recent, farmers in China have been using this process since 540 AD. Rice cultivators in China increase their crop yield by about 25 per cent by using Azolla. This is an aquatic fern which when grown together with rice can result in substantial nitrogen accumulation. During the 36 days before and after rice transplantation, Azolla can give a total of 120 kg of nitrogen per hectare.

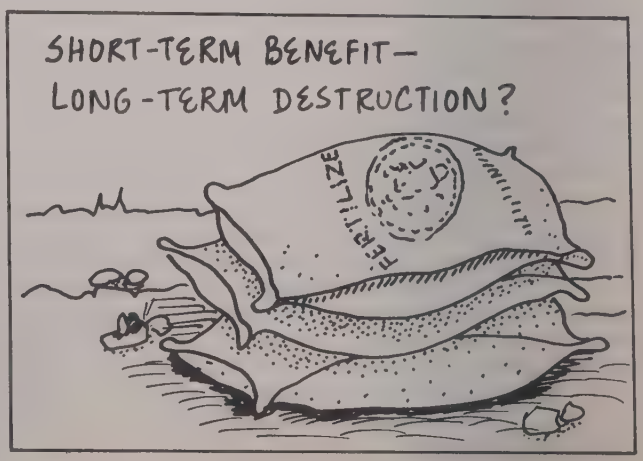
Studies carried out by ICRISAT have shown that various grasses, sorghum and millet varieties have considerable differences in associated bacterial nitrogen-fixing activity. This suggests that it may be possible to select and breed new varieties of sorghum and millet for increased nitrogen fixation.

Simultaneously, many scientists have been studying the ability of certain fungi to make soluble forms of phosphorus available to plants. Unfortunately, with some of these experiments, although results in the laboratory have been encouraging, field trials have not provided many positive reports.

In fact, a major review of the current research in biological nitrogen-fixation research points out that although this research has been outstandingly productive of sophisticated basic information during the past 20 years, it has had no significant practical applications as yet.

The most talked-about prize of genetic engineering research — building a nitrogen-fixing ability into cereals like rice and wheat, similar to the nitrogen-fixing ability of legumes — still remains out of reach. Even if a breakthrough is made, it is unlikely that it could be widely applied before 2000.

The future of organic fertilisers will depend on the seriousness with which governments fund and promote appropriate scientific research. If this seriousness fails to emerge, the country will reap short-term benefits but move towards long-term disasters. Destroying the fertility of our soils will be something like killing the goose which laid the golden egg, the unwarranted and unnecessary destruction of a renewable resource because of greed and lack of foresight.



Desertification and the Thar

Seven thousand years ago the Thar desert received abundant rainfall, hosted shrubs and trees including the jamun, was criss-crossed with rivers and lakes, and was home of a thriving civilisation. So states a five year study by a multi-disciplinary team of scholars.

Today, however, it is barren desert. There have been fears expressed that the Thar is spreading. But the main problem faced by this desert area, which stretches across parts of Rajasthan, Gujarat, Punjab and Haryana, is desertification in areas where there was some vegetation.

Recognized as a worldwide environmental problem, desertification threatens the future of about 628 million people around the world. An area twice the size of Canada — or 20 million sq km — is in imminent danger of being turned into a desert.

The cause of this process is not climatic changes, droughts etc but human actions. Increase in population and lack of alternative employment opportunities have left the people living in the Thar with no choice but to continue grazing cattle even in its inhospitable conditions.

The Thar desert has seen an unprecedented growth in its population in the last 70 years — from 3.57 million in 1901 to 10.24 million in 1971. A commensurate rise in the cattle population has put unbearable pressure on the restricted grazing area that exists in the desert. In 20 years the cattle population shot up from 10.27 million in 1951 to 16.44 million in 1971. Additionally, there has been an increase in the net sown area between 1951-71 of 25.3 per cent, therefore decreasing the grazing lands.

Development activities such as road building, urbanisation, canal and rail track construction have mobilised stable sand belts leading to a further spread of the desert. Deforestation — in this case the felling of the few trees that exist for fuel — has also added to the overall thrust of the desert.

According to studies conducted by the Central Arid Zone Research Institute (CAZRI) in Jodhpur, 9290 sq km or 4.35 per cent of Western Rajasthan has already been desertified in the last years and a further 76.15 per cent or 162,900 sq km is vulnerable to desertification. The Thar desert already covers 3,17,000 sq km and supports a population of 19 million, a density of 61 persons per sq km compared to three persons per sq km in arid regions elsewhere in the world — making it probably the most densely populated desert in the world.

Unless swift conservation measures are taken — rather proper development opportunities are found for the local people — the increasing density of the human and cattle population in this desert area will inexorably lead to further desertification.

UNICEF/BHAWAN SINGH

Saving crumbling hillsides

A chance discovery by a soil scientist has literally saved the village of Sukhomajri in the Shivalik hills, near Chandigarh, from disappearing.

A village of 455 inhabitants, Sukhomajri lies along the course of Sukhana "choe", a local name for the massive gorged river beds common in the Himalayan foothills. At the beginning of the century these choes brought fertile silt to the farmers in the valley; today they are the carriers of sand, gravel and boulders. Every year, as the monsoon water rushes down the choes, they become wider and eat further into the hillsides.

The Sukhana choe caught the attention of soil scientists because it was responsible for silting up the showpiece Sukhana lake in Chandigarh whose depth has reduced from 14 metres to four metres in the course of 20 years. P.R. Mishra, project director of the Central Soil and Water Conservation Research and Training Institute (CSWCRTI), was given the job of desilting the lake. As he followed the course of the Sukhana choe looking for the source of the problem, he chanced upon Sukhomajri.

Environmental deterioration in the village and surrounding areas has been dramatic. In 1968, several acres of productive village land pluged 40 to 50 feet into a deep gorge at one end of the village. In 1975, when Mishra visited Sukhomajri, it had no irrigation water and no electricity. The villagers lived off grazing cattle and goats on slopes just barely covered with grass and shrubs. Those unable to survive in this manner took jobs in tractor, cement and machine tools factories nearby or worked as casual labourers outside the village.

The villagers were aware that grazing cattle in certain areas was aggravating erosion, but they had no alternative. Mishra convinced them that building small reservoirs would solve their water needs, meet their fodder requirements and also check erosion. He made a bargain with the villagers that if they stoped grazing their cattle in the watershed area, then they could cut grass from there for their cattle. CSWCRTI built three small reservoirs varying between 200 to 400 feet in diameter; these catch the rain water which can then be used for irrigation. The watershed area, now not grazed upon, has regenerated and is covered again with grasses, shrubs and trees.

Conservation methods have checked further erosion. The gullies around the 60 foot deep gorge at one end of the village have been planted with grasses, shrubs and trees which help to hold the soil in place.

With the increased water supply, farmers are growing two and even three crops. Grass production, which averaged 200 kg per acre before, is now over 2500 kg per acre.

EARTHSCAN/MARK EDWARDS

A unique system of water sharing was devised in Sukhomajri. Each family, irrespective of the amount of land it owns, or the crops it grows, or even if it is landless, is entitled to a water coupon which it can use, loan out or sell. Everyone is thus given an equal amount of water; those wanting more can buy coupons from others. But the decision to sell rests with the coupon holder and the village-based Water Users' Association (WUA).

This system could work because Sukhomajri is different in a number of ways from other villages. There is little disparity in land ownership patterns and virtually the entire village belongs to the Gujar caste. However, despite these factors, inequalities have emerged amongst the villagers as a direct consequence of irrigation facilities. The larger farmers, who have lands in the command area, have been using the water for wet cultivation, even during the kharif season thus depriving the smaller farmers, farther away from the dams, of adequate water during the rabi season when the water is scarce. As there is not a single tubewell in Sukhomajri, and as most springs in the Shivalik region are dry, the reservoir water is precious.

Another reason the Sukhomajri project cannot be viewed as a universal example is because a great deal of money has been poured into it — because of its importance to Chandigarh. It is unlikely that many other villagers would attract so much funding and attention. But it does show that the job of soil conservation can be done — and this is certainly cheaper than dredging lakes. While the city of Chandigarh has already spent Rs 2.7 crores on dredging the Sukhana lake, the Sukhomajri project has spent only Rs 80,475.

"Farming is too serious a business to be left to farmers alone; the rest of the community will have to lend a helping hand . . . We should introduce a compulsory course on 'our agricultural balance sheet' in every class from the primary school to the University. Such a course should not be classroom-bound. It should involve taking long walks in the country at least once a month. The teacher who accompanies the students must have the capacity to discuss the beneficial and harmful impact of human activities on the biological potential of land and water . . . If, however, the teacher who accompanies the student is not equipped . . ., the visits may degenerate into sterile picnics. Hence teacher training must precede the introduction of such programmes."

Excerpted from Dr M.S. Swaminathan's Presidential Address "Indian Agriculture at the Crossroads", delivered at the 37th All-India Agricultural Economic Conference.

WATER

Seventy per cent of all the available water in India is polluted. About 73 million workdays are lost due to water-related diseases.

Before the Yamuna river enters Delhi 100 millilitres of its water contain about 7500 coliform organisms. After it receives Delhi's waste waters, the coliform count skyrockets to 24,000,000 per 100 millilitres.

In a 158 km stretch of the Hoogly, the average annual yield of fish in the unpolluted and polluted zones was 719.25 and 124.94 tonnes respectively.

The spectre of mercury poisoning haunts the residents of Ambivali village on the banks of the Kalu river. Dead fish, dying plants, poisoned livestock, paralyzed human beings and infirm children make up a deadly cycle in Ambivali.

As of 1981, out the hundred odd prosecutions launched after the enactment of the Central Prevention of Water Pollution Act 1974, only a few of the actual offenders have been penalized.

Wherever the people have organized, protested and challenged the polluters, they have pushed the State to act.

2

WATER

Many of us who are accustomed to receiving fresh water by simply opening a tap, perhaps do not realise how precious this natural resource is. A document prepared for the United Nations World Water Conference held in Argentina in March 1977, revealed that if all the world's water were represented by a half gallon bottle, the quantity of fresh water would be about half-a-teaspoon. And, a single droplet would suffice to represent the surface flowing water, the rest being groundwater.

In numbers, a mere 0.03 per cent of the world's total water fills our roaring rivers and streams and the quiet lakes and ponds outside the polar caps. But fresh water is getting scarcer everyday as communities, industries and agriculturists pour their filth, muck and untreated wastes into the nearest sink. "The day is not far off when a drop of water will cost more than a drop of oil," a Syrian delegate warned the UN Conference.

The total available water for use in India is estimated at 1900 billion cubic metres (cu m) per year. About 86 per cent of this is from the surface run off — in rivers, streams, lakes and ponds. Excluding groundwater resources, that still need to be tapped, surface flow represents 97 per cent of the available water.

The Himalayan rivers form a mighty network of snowfed and perennial waters, including the Ganga and the Brahmaputra river systems and the Indus river tributaries. The Ganga along with its major tributaries the Yamuna, the Ghagra, the Gandak, the Gomti, the Kosi and the Sone rivers has a length of 8047 km. The portion of the Brahmaputra system in India is over 4000 km long.

The major rivers of peninsular India are the Mahanadi, the Godavari, the Krishna, the Cauvery, the Narmada and the Tapti. The Godavari basin is the second largest in the country, serving over 10 per cent of its area. The coastal rivers rise in the Western or Eastern Ghats and after a short traverse, flow into the nearby seas. In addition, there are a few other inland rivers like the Luni, the Khan, the Kshipra, etc. The peninsular and other rivers are rainfed, mostly non-perennial and thus their volume fluctuates during the year.

A staggering 70 per cent of the available water in India is polluted, according to scientists at the National Environmental Engineering and Research Institute (NEERI). "From the Dal lake in the North to the Periyar and Chaliyar rivers in the South, from the Damodar and Hooghly in the East to the Thana creek in the West, the picture of water polluting is uniformly gloomy. Even our large perennial rivers like the Ganga are today heavily polluted," admits the Planning Commission.

Community wastes, from human settlements, account for four times as much waste water as industrial effluents. Most of these wastes are discharged untreated into the water courses. Out of India's 3119 towns and cities, only 217 have partial (209) or full (8) sewerage and sewage treatment facilities. These cover less than a third of the urban population.

The implications of such massive pollution, for the health of the nation, are extremely serious. According to one estimate, two-thirds of all illnesses in India are related to water-borne diseases, such as typhoid, infective hepatitis (jaundice), cholera, diarrhoea, and dysentery. Many of them assume epidemic proportions.

In 1955-56 pollution of the Yamuna river resulted in 40,000 cases of jaundice in Delhi and a few hundred deaths. In 1978, 2000 attacks of jaundice were reported in Bombay due to pollution of water in the supply mains. "Such epidemics are on the increase and smaller outbreaks and sporadic cases go totally unnoticed," observe N.S. Deodhar and K.J. Nath of the All-India Institute of Hygiene and Public Health in Calcutta. "In poor communities, diarrhoea and dysentry have become a part of life."

It is also estimated that 73 million work days are lost every year due to water-related diseases. The cost of treating them and the loss in production amount to Rs 600 crores a year.

Water pollution severely affects aquatic life. Occurrences of massive fish kills and the destruction of lower aquatic life forms, due to industrial pollutants, have become a common feature in various parts of the country. Dead fish means the loss of a major source of protein, and worse still, a livelihood, for millions of Indians.

Industrial production is also affected. Tanneries in Kanpur are the cause and the victims of increasing hardness of the available water. The drastic rise in pollution in the Damodar river is affecting the power units of the Durgapur Projects Limited. The latter's demineralizing plants get exhausted in 4 hours instead of the rated eight.

In recent years, people, especially in rural areas, have become acutely aware that water pollution poses a threat to their lives and livelihoods. Sustained campaigns against polluters in Goa, Kerala, Shahdol (Madhya Pradesh), Ganjam (Orissa), and Burhanpur (Gujarat), among other places have forced government officials to take notice and sometimes act. The Water Pollution Prevention and Control Act of 1974 was enacted, at least partly, due to public pressure. The progress in its implementation, however, has been unsatisfactory and uneven.

The Indian Government is a signatory to the International Decade of Drinking Water and Sanitation, 1981-1990 whose objective is to provide safe water and sanitation to all. This will first require cleaning up our water resources.

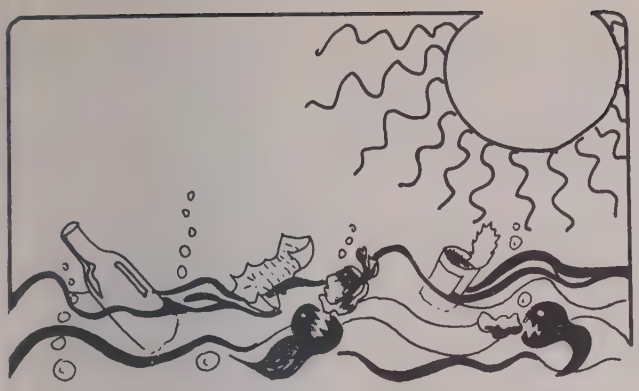
Seventy per cent of the available water in India is polluted. Small, snow-fed Himalayan streams are among the few fresh-water sources that remain unpolluted. (Indian Express/M. Mahatta)

NATURE OF WATER POLLUTION

The earth is an oxygen-water planet. Oxygen and water are essential for all life. Water is used everywhere — for drinking, washing, bathing, irrigating, cooling, and manufacturing almost anything. It is the universal solvent. Water is thus despoiled everywhere.

The only large scale agency for restoring water to a state fit for further use is Nature. The sun's heat evaporates the water of the oceans and returns it to earth as rain. The rivers "inhale" oxygen with every swirl of the water and green aquatic plants yield more oxygen to the waters through photosynthesis. As long as this natural process of recuperation can match the process of despoilation, the rivers sustain life. But modern industrial society is rapidly overtaking this natural cleaning capacity.

Ecobalances are parts of a huge interconnected system. Scientists understand only a few of these balances, the rest continue to give notice of their existence through various warning signals.



What happens when a load of rubbish is thrown into a river? As the solids sink to various levels in the water, they are attacked by two kinds of organisms: the aerobes, which cannot do without oxygen and hence populate the oxygen-rich upper layers; the anaerobes which shy away from oxygen and so live in the depths. Each consumes the rubbish descending to its level, converting the complex organic materials into inorganic and mineral matter that cannot putrefy and so despoil water.

The aerobes begin multiplying as soon as they sense the presence of the rubbish. As they consume the dissolved and suspended wastes, they use up the oxygen present in the water. Algae present in the water then absorb the inorganic and mineral matter produced by the aerobes and convert it back into useful organic matter. In process they release oxygen into the water through photosynthesis.

Along with the solid matter in the rubbish there are also likely to be a host of disease germs released into the water. Rivers contain a variety of aquatic protozoa that destory many of these germs. The oxygen required for the survival of the protozoa comes from the intake of the rivers or from the algae.

When the quantum of waste goes up, the amount of oxygen required to consume it, by the aerobes and the protozoa increases. But the river can only supply a limited amount of oxygen. As this oxygen begins to deplete the aerobes and protozoa begin to die off. Finding the oxygen levels falling in the upper layers, the anaerobes rise and begin attacking the waste matter. This they do by extracting hydrogen. The hydrogen combines with sulphur from the wastes to produce the foul-smelling hydrogen sulphide gas. The water becomes turbid and sunlight cannot penetrate the surface. The algae, in the absence of sunlight, begin to die and so do the fish. What remains is a "foul" river, smelly, and sluggish, devoid of life and a menace to all other life. This can be seen happening — over and over again.

Table 1. Pollution control standards

Characteristics	Sewage IS 4764-73	Industrial effluents		Inland surface water IS 2296-74
		Inland surface water IS 2490-74	Public sewers IS 3306-74	
BOD (5 day 20°C), mg/l	20	30.0	500.0	3.0
COD, mg/l	—	250.0	—	—
pH	—	5.5-9.0	5.5-9.0	6.0-9.0
Total suspended solids, mg/l	30	100.0	600.0	—
Temperature, °C	—	40.0	45.0	—
Oil & grease, mg/l	—	10.0	100.0	0.1
Phenolic compounds, mg/l	—	1.0	5.0	0.005
Cyanides, mg/l	—	0.2	2.0	0.01
Sulphides, mg/l	—	2.0	—	—
Fluorides, mg/l	—	2.0	—	1.5
Total residual chlorine, mg/l	—	1.0	—	—
Insecticides, mg/l		zero	—	zero
Arsenic, mg/l	—	0.2	—	0.2
Zinc, mg/l	—	5.0	15.0	—
Chloride, mg/l	—	—	600.0	600.0
Sulphates, mg/l	—	—	—	1000.0
Ammoniacal Nitrogen, mg/l	—	50.0	50.0	—
Nitrates, mg/l	—	—	—	50.0
Radioactive materials:				
alpha-emitters, uc/ml	—	10^{-7}	—	10^{-9}
beta-emitters, uc/ml	—	10^{-6}	—	10^{-8}
Dissolved Oxygen, mg/l	—	—	—	40% of saturation value, or 3 mg/l, whichever is higher
Coliform organism (monthly average) — MPN per 100 ml	—	—	—	under 5,000

Source: Deodhar and Nath, "Water pollution and its control in India", Indian Science Congress 1981.

How are these processes disturbed when other ecological balances enter the picture? How does the building of bridges and piers affect the turbidity of rivers? How does industrial cooling, which raises the temperature of rivers, affect the aerobes and protozoa? How do trace metals enter the food chain when sewage water is used for irrigation and with what effect? How do flood prevention measures and hydro-electric projects influence the breeding patterns of fish? On an oxygen-water planet what all eventually disturbs the delicate balance between the two? We really don't know the complete answers to these questions.

Scientists have devised various parameters for measuring the pollution and purity of water. Wastes discharged into a river are quantified as total solids (TS). Some of them are absorbed as dissolved solids (DS), the rest being suspended solids (SS). The principal bacteria that accompany these solids are the coliforms and the faecal coliforms or E, coli. These are measured in terms of the Most Probable Number (MPN).

Table 2. Water pollution from selected industries

INDUSTRY	Waste water generated (million m^3/year)	POLLUTANTS				REMARKS
		BOD (mg/l)	COD (mg/l)	Suspended solids (mg/l)	Others (mg/l)	
Cotton textiles	1,530	200-300	400-800	350-550	Chlorides 500-1,400	Highly alkaline; discoloured and hot effluent.
Nitrogenous fertiliser	52	—	—	—	Total nitrogen 1,250 Fluoride 15 Arsenic 1.6 Phosphates 70	Nitrogen in ammonia is deadly to fish; nitrates are hazardous to livestock and humans; effluents are highly alkaline and slightly brownish.
Paper	450	160	725	410	—	High or low pH depending on process used.
Pesticides	—	upto 700	3,000-10,000	—	Organic nitrate 0-500 Sulphate 3,000-20,000	pH can vary from acid (2) to alkaline (10); effluent is highly toxic to aquatic life.
Oil refinery	15	160	320	350	Phenol 20 Sulphides 9 Phosphates 49	
Integrated steel plants	40	75-100	200-2,000	—	Phenol 20-60	Acidic effluent; high in suspended solids.
Sugar	225	300-2,000	600-4,000	220-800	Total nitrogen 10-40	

Source: Deodhar and Nath, "Water Pollution and its control in India", Indian Science Congress, 1981.

For consuming and destroying these solids and bacteria, oxygen is required by the aerobes and protozoa. This oxygen comes from the dissolved oxygen (DO) in the water. The amount of oxygen required to sustain these organisms is called the Biological Oxygen Demand (BOD). The Chemical Oxygen Demand (COD) refers to the oxygen used up in converting organic wastes to inorganic materials. When the COD and the BOD levels begin to overtake the DO levels then rivers begin to die. Other parameters like temperature, pH, free ammonia, chloride, nitrite, nitrogen, turbidity, conductivity, hardness, trace metals content, are also measured to assess the water quality.

For each of these parameters, scientists specify a range of "acceptable" values for different activities (see Tables 1 and 2). The specified values are, however, often dependent on economic as well as technical conditions. Thus, for instance, MPN values for potable water should ideally be zero per 100 millilitres (ml). British water supply plants accept 1 to 3 per 100 ml as satisfactory while the Japanese specify MPN values less than 50 per 100 ml for class I waters.

The Indian Standard (IS: 2296-1974) for inland surface water recommends an average MPN not exceeding 5000 per 100 ml. Before the Yamuna enters Delhi, 100 ml of water contain about 7500 coliform organisms. But further downstream at Okhla, after it has received Delhi's waste waters, the MPN skyrockets to 24,000,000 per 100 ml, according to tests conducted by the Central Board for Prevention and Control of Water Pollution (CBPCWP). In Kanpur, MPN values for the Ganga, as high as 10^5-10^5 per 100 ml were measured as far back as 1966. Today, the situation is only likely to be worse.

Pure clean water should have a BOD less than 5 parts per million (ppm) or 3 milligram per litre (mg/l), but municipal wastes regularly exceed this figure, even after treatment. Suspended solids should be less than 100 mg/l, but this limit is observed only in its violation. Large-scale pollution of the Damodar river near Asansol results in BOD values as high as 270 mg/l and suspended solids exceed a concentration of 100,000 mg/l.

Thus, while standards exist, they are not enforced.

RIVER POLLUTION IN INDIA

River water pollution in India has reached a crisis point. A list of India's polluted rivers reads like a roll of the dead.

Ganga river system.

The Ganga river system has been converted into a network of cesspools and drains by the industries and municipalities in the region. The Ganga, despite its high self-purification capacity is among India's most polluted rivers. (See next section)

Shockingly high levels of pollution exist along vast stretches of the Yamuna river. Everyday, its 48 km portion through Delhi, picks up nearly 200 million litres of untreated sewage. Twenty million litres of industrial effluents including about half-a-million litres of DDT wastes enter the Yamuna in this stretch. (See box: Yamuna, an open sewer)

From Delhi to Agra, the Yamuna water is unfit for drinking and bathing. A survey by the CBPCWP predicts that if the sewage from Delhi's 17 drains are not treated properly and soon, it will be highly polluted from Delhi to Allahabad. At present, the waters of six tributaries dilute the polluted wastes before Allahabad.

One of the major tributaries of the Yamuna is the Chambal river. The latter is Rajasthan's biggest as well as most polluted river. Kota, the site of a fertilizer complex, an atomic power station, a thermal power unit and other industrial units adds toxic effluents including urea, ammonia, chlorine, lead, mercury and other metals. Aquatic life has been destroyed. The Chambal's water is unfit for consumption as evidenced by the large number of cattle deaths.

A 35 km stretch of the Gomti receives about 180,000 cu m of sewage and wastes from pulp and paper factories near Lucknow, everyday. A high MPN of coliform bacteria 34,000 to 144,000 per 100 ml, an average BOD count of 160 mg/l (maximum upto 2000 mg/l) and SS concentrations upto 964 mg/l have been recorded. The recovery is not complete even 65 km downstream from Lucknow due to the river's low self-purifying capacity.

The Sone river suffers heavy pollution near Dalmianagar, where effluents from paper, chemicals, cement and sugar factories are discharged into its waters. Many years ago, carp fish were eliminated here, along a 22 km zone. Discharges from paper mills and chemical units at Mirzapur (Bihar) are so toxic that the fish mortality rate is the highest recorded for an Indian river.

Rising in the Chota Nagpur hills, the Damodar river flows its 540 km course first through the mining belt of Bihar. It then receives effluents from chemical and metallurgical factories between Bokaro and Sindhri including the Bokaro steel plant, a thermal power station and the Sindhri fertilizer unit. The lower Damodar Valley from Asansol to Durgapur is one of the most highly industrialized regions in India. Seventy major industries and 250 coal mines are spread around Asansol alone. In terms of oxygen depletion, eight industrial units in Durgapur dump wastes that are equivalent to the sewage from a city of one million population. Fish kills are a common occurrence in summer. "The river is heading towards ecological disaster," predict A.V. Natarajan and B.B Ghosh of the Central Inland Fisheries Research Institute in Calcutta.

The Damodar finally joins the Hooghly near Calcutta. "Near Calcutta, Tolly's Nullah, a canal from the Ganga and the Hooghly .....are the regular dumping grounds for the city's dead and putrefying dogs and cats. The sight and stench of carcasses has put an end to boat cruises on the the Hooghly," wrote Sunanda Datta-Ray in an "Earthwatch" publication. (Also see next section, on the Ganga.)

Peninsular rivers

Data or detailed reports on the pollution of the peninsular rivers are scanty.

The Godavari river at Rajamundhari receives the effluent of a paper mill. The 2.4 km polluted stretch was long ago covered with aluminium hydroxide, killing plankton and other aquatic life on the river bed. Hot water discharges from the Kothagudem thermal power station have destroyed aquatic life in the Soni river, a tributary of the Godavari.

An 18 km stretch of the Bhadra river, a part of the Krishna river system, suffers high fish mortality and other problems due to discharges of pulp, paper and steel mills at Bhadravati. The Bhadra and the Tunga rivers join to form the Tungabhadra, a major tributary of the Krishna. The pollution of the Tungabhadra by the Harihar Polyfibres factory at Harihar is one of the horror stories from Karnataka.

The Cauvery is Tamil Nadu's main river and also the most polluted. It receives wastes from paper and chemical plants. The Bharat Heavy Electricals Limited has been reported to dump lethal chemicals into it. Effluents from tanneries have given it a strong colour and distillery wastes have led to mass fish kills.

The Damodar Valley is one of India's most highly industrialized regions. Pollutants from the heavy industries along the banks of the Damodar river are converting it into an ecological disaster. (SPAN/A.C. Pasricha)

Channeling of raw sewage from Hoshangabad town into the Narmada has led to a spurt in enteric diseases and skin problems among the hundreds of daily bathers in this river. The public sector Nepanagar Paper Mills consistently dumped untreated effluents into the Tapti before installing a Rs. 2.5 crores filter plant, under court orders.

Coastal rivers

The coastal rivers are relatively short and rain-fed. Their torrential flow during the monsoons reduces to a trickle in summer.

Periyar, the largest river in Kerala, has a number of factories on its lower banks; including fertilizers, chemicals, metallurgical and rayon units. Over 170 million litres of effluents are discharged into the river containing suspended solids, metals, urea, ammonia, fluorides, chlorides and other chemicals. The presence of mercury and radioactive wastes (from the Indian Rare Earths Ltd.) in the effluent, is a cause for serious concern. The toxic chemicals affect the aquatic flora and fauna. Fish kills have been common. Due to forceful action by the Kerala State Board for Prevention and Control of Water Pollution, treatment measures by the industries have visibly improved its water quality.

The lower stretch of the Chaliyar river is substantially polluted by the Gwalior Rayons factory at Mavoor. The 54.8 million litres of effluents dumped into the river contain inorganic and organic matter creating a high content of COD and BOD, suspended solids and metals like zinc. For a stretch of about 5 km, the river contains no dissolved oxygen in the summer months. (See box on KSSP)

The Kalu river which flows through Bombay's industrial suburbs of Ambarnath and Ulhasnagar, has a dangerously high concentration of mercury and lead near Ambivali village. A monoculture of the plant species Pycreus macrostachyos growing on the river banks, accumulates both mercury and lead. Milch cattle grazes on these plants and the heavy metals enter the food chain. Since these are "cumulative" poisons, the people is this area, especially children who drink milk, are being slowly poisoned (See box: Bombay's Minamata)

The Rushikulya is a small coastal river in Orissa. Chemical wastes from the Jayshree Chemicals Limited (JCL), a Bangur concern which manufactures caustic soda, have eliminated the Khainga fish from the river. Total fish catch has declined from 200 kg a day in 1967, before the JCL started operations, to a bare 5 kg per day. Eight hundred

Bombay's Minamata

The name of Minamata sends shivers down the spines of environmentalists across the world. In the early fifties, residents of this fishing town in Japan were struck by mercury poisoning caused by eating fish that had been contaminated by the wastes of a nearby factory. By 1972, almost 300 persons were officially listed as its victims. The symptoms of Minamata disease were madness, paralysis, loss of speech and vision, loss of emotional control and crippling of arms and legs, all brought on because of damage to the central nervous system. In the final stages, the victims muscles wasted away, leading to coma and in many cases death.

A series of investigations by the Institute of Science in Bombay reveal that industries on the banks of the Kalu river, on the outskirts of Bombay are recreating another pollution disaster. "The spectre of Minamata stares in the face of the village population that consumes fish and food from or near the Kalu river," says Dr B.C. Haldar who led the investigations.

Kalu is a small river which originates in the Western Ghats. It flows through the industrial suburbs of Ambarnath, Ulhasnagar, and Kalyan in north-east Bombay and finally empties into the Arabian Sea approximately 50 km north of Bombay. It receives effluents from over 150 industrial units.

The Institute of Science investigated a stretch of 10 km from Ambivali to Titwala, along which toxic wastes from a rayons factory, a paper mill, a dye factory and a chemical plant pour into the river. During 1978 and 1979, they surveyed the water quality and the effect of the pollutants on plant and animal life.

Industrial effluents in the river at Ambivali contain metals (mercury, lead, copper and cadmium), chlorides, dyes, organic acids, etc. The water is therefore, discoloured, acidic and saline. By the time the river reaches Titwala, the water quality is slightly better; it is colourless, neutral but saline and the sediment here contains a high amount of heavy metals. This is most likely due to the latter being swept in from Ambivali to Titwala during high tides. "The water at the point of discharge of effluents into the Kalu river has a mercury content equal to that at the centre of the Minamata Bay," emphasizes Dr Haldar.

The metallic content of the effluents fluctuates, and at times lead and mercury concentrations rise above the permitted levels. The real problem, however, is not the amounts of these metals in the water, but their accumulation in the sediment. These elements are insoluble in water and sink to the bottom. Certain bacteria in the river bed convert the insoluble mercury into soluble methyl mercury which is a deadly poison and can be absorbed by living organisms. Thus, mercury enters the food chain. The fish get poisoned and cattle that graze on the plants in shallow water also accumulate mercury.

"Heavy metal contents of pycreus plants, the most abundant at Ambivali, showed unusally high concentrations. Leaves of these plants contain from three to 110 ppm of mercury. The rhizomes of the same plants contained 6.9 to 53.3 ppm," reveals the report of the Institute of Science.

There is five ppm of mercury in the milk of milch cattle that graze on the pycreus plants. A child drinking one litre of this milk everday day consumes 35 ppm of mercury in a week. Over a period of several months this can lead to accumulations of over 0.3 mg of mercury which is well above the safe level. "Symptoms of mercury poisoning are already discernible: peculiar cramps and convulsions, sapped energy, hearing impairment, damaged vision, lunatic fringe, numb sensation et al," states a report in "Imprint" magazine. "Ambio" the Swedish journal of human environemnt reports many cases of paralysis in the area.

The fish that are not poisoned by mercury are killed by other toxic wastes. Thus, dead fish, dying plants, poisoned livestock, paralysed human beings and infirm children, make up a deadly cycle in the village of Ambivali.

Further studies carried out by the Institute of Science show that the problem of toxic chemicals may also be spreading to other aquatic environments in and around Bombay. "The results of a survey of fish from seven sources in Bombay have revealed that bones and muscles of *Jitadi, Boity* and some other varieties of fish have mercury concentrations greater than 500 nanograms (one-billionth of a gram) per gram which is the safe limit," points out Dr Haldar.

But the industrial lobby is very powerful. There are unpublished reports of senior officials of the Maharashtra Board for Prevention and Control of Water Pollution resigning after being frustrated by politicians in their attempts to obtain compliance by the industries along the banks of the Kalu.

Further pollution of Bombay's waters and cleaning up of the Kalu river is unlikely to happen without public pressure: a major challenge before the environmentally conscious citizens of Bombay. The Japanese environmentalists even had to wage a long struggle to prove that Minamata disease was, in fact, a case of pollution poisoning.

fishing families unable to bear hunger, have migrated from Ganjam. Polluted water flowing through irrigation channels has hit paddy production in 13 villages. Various State and Central Government agencies have sent investigative committees to the area but no effective action has been taken according to a newspaper report.

Other Inland rivers

The rivers of Madhya Pradesh have turned into a network of drains. Some 220 industrial units including paper mills,distilleries and textile mills produce 675 million litres of waste. The M.P. State Board for Prevention and Control of Water Pollution has served notices on 170 units. Barely one fifth of them had set up treatment plants in 1980. "What the people of Bhopal (the state's capital) drink is gutter water," remarked a former State Governor.

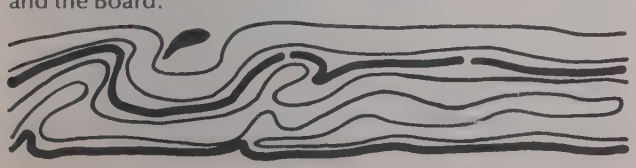
The Khan river originates at Nimoli tank near Indore and flows for 64 km before joining the Kshipra near Ujjain, where thousands of Hindus congregate for the Kumbha festival. a sepsis zone exists for three-quarters of the Khan's length. Indore city pours over 35 million litres a day of raw sewage and industrial effluents. The BOD value rises to 250 mg/l at this stage and the Dissolved Oxygen content is zero. Well water in 22 villages has been rendered unfit for drinking just before it joins the Kshipra. The Khan undergoes natural aeration at a series of rapids and falls. In response to public protests, the district authorities have installed a Rs 150 million treatment plant to ensure safe water for Ujjain.

In general, the volume of untreated municipal wastes, entering our rivers is much greater than the industrial effluents. But the former are less harmful to the rivers because they are highly biodegradable. The municipal wastes do pose a grave threat to millions of people who use the waters in the polluted stretches. Industrial pollutants are highly toxic to plant and animal life. Since some toxins can enter the food chain, particulary heavy metals, they are also hazardous to people.

The Planning Commission has recently sanctioned funds for a massive research programme to study the nature and extent of water pollution in the Ganga alone, involving a number of universities and research institutions in this region. Equally necessary is a detailed study of the effect of the polluted waters of the entire Ganga river system on the lives of the people who use its waters. After all, over a third of India's population depends on this system for drinking water.

The dismal picture of river pollution in India exists despite the enactment of the Water Pollution Control Act in 1974. This is partly due to its feeble enforcement by most of the State Pollution Control Boards. "We don't want to scare away industries from this backward state," explains D.V.S. Murthy, Chairman of the M.P. State Board.

In some states like Kerala and Maharashtra, the Boards have been quite firm and relatively more effective. But the Chaliyar river in Kerala and the Kalu outside Bombay are symbols of industry's open defiance of statutory regulations and the Board.



THE GANGA: OLD MYTHS AND NEW

The oldest myth about the Ganga river is ensconced in the tale of Bhagirath who was able to persuade the goddess Ganga to come down from heaven to earth and of Shiva who had to capture the torrential fall in his hair so that the earth would not get destroyed. The newest myth was created by a courageous Union Cabinet Minister who foolhardily declared before Parliament that the Ganga could never be polluted. Between these two myths lies the sacred attraction that the river has for millions of Hindu pilgrims, washing away their sins in the holy waters during life and with their ashes being immersed later in death.

The Ganga drains the southern slopes of the Himalayas and part of the northern slopes of the Vindhya ranges, sweeping vast amounts of snow and rainfed water into the Bay of Bengal. The Ganga river system drains about a quarter of India's land area.

Along every kilometre of the Ganga in Uttar Pradesh Bihar and West Bengal, people and factories are pouring their garbage, excreta and muck into what is gradually turning from river to drain. An investigation conducted by the Central Board for Prevention and Control of Water Pollution says that none of the large cities on the banks of the Ganga has a sewage treatment plant although most of them have partial sewerage facilities. In all, 48 class I cities and 66 class II towns dump largely untreated sewage into the river every day. To this is added the burden of other human activities like bathing, washing of clothes and immersing of ashes or unburnt corpses.

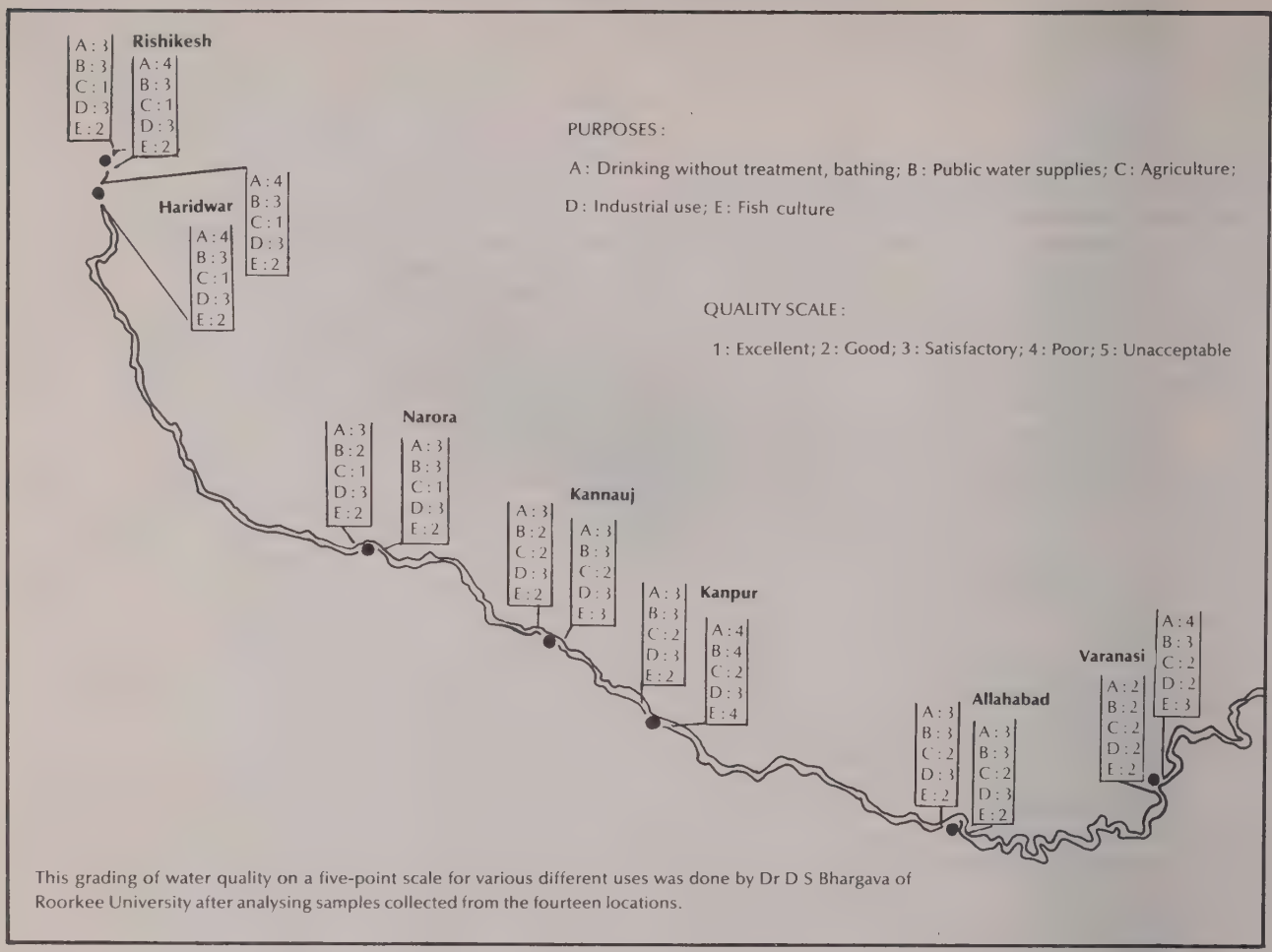
Industries contribute chemical effluents to the Ganga's pollution load. DDT factories, tanneries, paper and pulp mills, petrochemical and fertilizer complexes, rubber factories and a host of others use the river to get rid of their wastes. The volume of these effluents is less than that of sewage — 18 per cent for Kanpur, four per cent for Allabahad and five per cent for Varanasi. A number of scientific investigations show that downstream of Varanasi, the industrial component increases rapidly and the toxicity extinguishes fishes from large sections of the river.

The threat of pollution from chemical fertilizers and pesticides appears to be relatively small but growing.

The data for Figure 1 were collected during the summer. It is immediately apparent that the sacred cities of Rishikesh, Haridwar, and Varanasi seriously affect the quality of the Ganga's water, particularly for drinking purposes. Allahabad, presumably, is saved from the attentions of the devout by the large inflow from the Yamuna; while not-so-sacred Kanpur has the distinction of adding industrial effluents as well as sewage, causing high mortality among fish. It should be borne in mind that the data used for this classification do not include all the indicators of industrial pollution.

The CBPCWP investigation reveals that about 10 km upstream from Kanpur city, the Ganga water quality is satisfactory. It deteriorates sharply after the city's water intake, at the Bhairon Ghat pumping station, upon receiving sewage from the city and wastes from textile mills and tanneries. The brown colouration caused by tanning from these wastes persists up to Kishanpur village, more than 10 km downstream. There are a number of waste water outfalls which discharge directly into the river in this stretch. In addition are discharges of condensor water from the power

Figure 1. The quality of the Ganga's water upstream and downstream of seven cities.



This grading of water quality on a five-point scale for various different uses was done by Dr D S Bhargava of Roorkee University after analysing samples collected from the fourteen locations.

house of the Kanpur Electricty Supply Administration, the pollution from many bathing and burning ghats, and the effluents from J.K. Rayons.

In 1980, the IFFCO fertiliser complex at Phulpur near Allahabad, went on stream, manufacturing 1550 tons of urea per day. The fertiliser complex, along with the local township, consumes about 13,500 cu m/day of water and discharges back into the river a total of 5,500 cu m/day of effluent. Heavy fish mortality and damage to some farm animals in a 16 km zone from the point of discharge were reported by scientists at the Central Inland Fisheries Research Institute in Allahabad.

A research team from Benaras Hindu University found that the Ganga water at Allahabad, Varanasi and Patna can be considered good for drinking purposes during the winter and summer seasons. It is unsafe during the monsoons because of a high amount of total solids in the water. The concentration of chloride was observed to be low; dissolved oxygen was near to saturation; the nitrogenous content was within permissible limits; and the population of phytoplanktons and zooplanktons was present throughout the period of investigation. No residues of DDT and Dieldrin could be detected in any of the samples. These are particularly important findings as they indicate the relative cleanliness of Ganga water in an area, largely free of industrialisation, where the river has to deal with only sewage discharges.

In the 256 km stretch from Barauni to Farakka, "the maximum pollution of the river takes place near Mokamah bridge where the effluents from the Bata Shoe Factory, the McDowell Distillery, the Oil Refinery, the Thermal Power Station, and the Fertiliser factory are discharged into the river," according to a study by Professors K.S. Bilgrami and J.S. Datta-Munshi of Bhagalpur University.

The Bata Shoe Factory and the McDowell distillery discharge 250,000 litres of unprocessed wastes per day. Experiments carried out to determine the toxicity of the wastes found fish dying within 48 hours of being placed in the mixing zone of the effluents from the Bata factory, and within five hours in the effluents from McDowell distillery. A high rate of mortality was also observed for fish and tortoises in the oil refinery effluent zone. The Bata Shoe factory was a menace even to coliform bacteria whose population dwindled at the discharge point, but they recovered strongly at the sewage discharge point of the oil refinery.

The wastes discharged from the oil refinery have been so large, that, in 1968 the Ganga was reported to have caught fire near Monghyr. The construction of the Farakka barrage without a fish ladder is preventing certain species of fish from reaching their breeding grounds at the upper reaches. It also provides a barrier where indiscriminate fishing can

take place on a large scale. In addition to the industrial activity more than 120 dead bodies are cremated daily at burning ghats in Bhagalpur, Sultanganj, Monghyr, and Simaria.

After Farakka, the main stream of the Ganga passes over into Bangladesh to join the Brahmaputra but a distributary, the Hooghly, branches westwards to flow into the Bay of Bengal, its flow augmented by other rivers such as the Damodar and the Roopnarain. It is a misfortune of the Hooghly that it passes through Calcutta and Howrah, centres of the most extensive industrialisation and population in the entire Gangetic plain.

The Hooghly estuary is choked by the untreated industrial wastes from more than 150 major factories around Calcutta including 87 jute mills, 12 textile mills, seven tanneries, five paper and pulp factories and four distilleries. Raw sewage pours into the river continuously from 361 outfalls.

It is commonly believed that an estuary cannot be polluted because of aeration and dilution by tides from the sea. But dilution by tides, argues Dr B.B. Ghosh of the Central Inland Fisheries Research Institute (CIFRI) in Calcutta, is "no solution to pollution."

"There is not much fish left in the Hooghly river," exclaims a senior official in the Ministry of Agriculture. The Hooghly was once considered to be a spawning ground for the Hilsa fish, whose catch is considerably reduced now. The effect of estuarine pollution of the Hooghly on fishing has been the subject of a number of studies by scientists at CIFRI. A recent study has noted that in the 158 km length from Nabadwip to Baj Baj, the average annual yield of fish in the unpolluted and polluted zones was 719.25 and 124.94 tonnes respectively, the average annual catch was 159 and 26 kg per hectare respectively.

Every river has a self-purification capacity. The Ganga because of its sheer size and volume of water it carries is considered to be more self-purifying than most. Can it, however, handle the massive amount of wastes thrown into it? Dr D.S. Bhargava told an international conference last year that between Rishikesh and Varanasi, the Ganga has the highest BOD rate constant value and the reaeration rate constant value among major rivers. Both of these are higher by an order of magnitude than any other values reported thus far. Dr Bhargava observed that coliform organisms reduced significantly in very short times. Thus the Ganga is able to handle fairly successfully the sewage wastes in short stretches. Toxic materials from industrial pollution are reduced mainly by dilution by additional water flows joining the river.

While the news that the Ganga may be the most self-purifying river has provided newspapers with good copy, it doesn't provide room for complacency. Referring to the Ganga's self-purification characteristic, the CBPCWP report says, "Now, however, the natural defences have been breaking down and urgent steps to halt the degradation are

Hundreds of devout Hindus congregate at Sheetlaghat in Banaras to bathe, pray, take holy dips or immerse ashes of dead relatives in the holy Ganga. (K.K. Chawla)

called for just upstream of the towns and cities." Thus, whatever self-purification the Ganga goes through is generally downstream of the centre of population and the population continues to bathe in and drink water that is significantly unhealthy.

So far, the scientific evidence about the nature and extent of the Ganga's pollution has come in bits and pieces. The CBPCWP is expected to release a compilation of all the available literature in December 1982. Integrated studies involving several universities have been launched as part of the Planning Commission's "sky to ocean" programme to fight the pollution of the Ganga. The Government has also decided to declare the Allahabad-Haldia stretch a national waterway, to avoid delays due to interstate disputes and thus make implementation of plans easier.

Every one of the research studies since the early 1960s has advised on the imperative need for controlling the Ganga's pollution, particularly from sewage and industrial wastes. But little has been done in the intervening twenty years to put into action the numerous suggestions made. In the public mind the Ganga flows on as of yore cleansing the sins of generations. Environmental awareness remains confined to committees and groups of concerned scientists.

Shiva is no longer required to protect the Earth from the Ganga; now the Ganga itself requires protection from the violence of people.

CITIZENS' EFFORTS

There are any number of causes that can spark off a protest movement against the despoilation of the environment, particularly by industry. Dead fish floating on the river, nauseous gases in the air, loss of livelihood, publicity of the adverse effects by voluntary groups, lack of employment in the industrial units for local people, a series of broken promises, dead or dying cattle, water that acquires strange hues and odours, election demands — all these and more, at some time enter the consciousness of the people and ignite protests against the assaults on their lives. In Goa, at Belgaum, in Kerala, Hoshangabad, Burhanpur, Gwalior, Ganjam and Shahdol; villagers, fisherfolk, students, journalists, and farmers have mobilised public opinion, often forcing administrations to set up enquiry committees, and sometimes to act. Most of the issues have focussed on industrial effluents, few have taken up campaigns against sewage pollution.

Zuari Agro Chemicals Limited, Goa

The company, a Birla concern supported by US Steel, the International Finance Corporation — a subsidiary of the World Bank — and the Bank of America, started operations in 1973. Within three months fish began to die; within a year cattle were also dying; and in another year, coconut trees began to wither away.

Much of the pollution had been anticipated and warned against. But the factory management had assured the Goans that all effluents would be suitably treated before leaving the plant. "Effluent from this plant is treated in a well-equipped treatment plant and brought within the stringent standards prescribed by Government," Mr. K.A. Varughese, the Managing Director had said at the factory's inaugural function.

Tailings or mining rejects from the surrounding open-cast mines have rendered this paddy field in Goa totally unfit for cultivation. (Ashish Kothari)

By 1975 protests began, but the factory management refused to acknowledge that the factory was responsible for the problems. A Citizens Anti-Pollution Committee was formed and a morcha was organised on March, 31, 1975. An ultimatum by the Goa Government on April 10 to the factory produced no results. On April 19 the District Magistrate ordered immediate closure of the factory.

Three political parties — the United Goans, the CPI, and the Goa Pradesh Congress-came to the support of the villagers at different stages of the campaign. A threat was also issued by the All-India Port and Dock Workers' Federation to boycott unloading of raw materials for the Birla factories at various ports. Eventually, Zuari Agro Chemicals paid Rs. 32,000 to about 50 farmers as compensation, paid some more compensation for fish destroyed, and installed 22 taps in affected areas for drinking water. In addition, a waste treatment plant was installed under the control of the Central Water Pollution Board. A significant blow albeit a limited one, had been struck against environmental piracy.

The degradation of Goa does not stop at Zuari. A sugar factory at Dayanandnagar dumped molasses into drinking water supplies; open cast mines allow their refuse to be carried away by run-off; a pelletisation plant at Shiroda causes flooding of agricultural land; and canning factories and sand extracting units are reducing Goa to bits of rubble.

Against each fresh intrusion, the people react with the limited organisational strength at their command. For technical support, they turn sometimes to the Goa Public Health Laboratory and at others to the Pune-based Gokhale Institute of Economics.

Orient Paper Mills, Amlai

Much before Zuari, another Birla concern, the Orient Paper Mills, began production at Amlai in Madhya Pradesh, in 1965. A government committee had warned against the pollution of the Sone river but factory management had promised that all possible steps would be taken to treat the effluent before discharge. Within two years the fish started to die, followed soon by cattle deaths. Finally the water became unfit for even bathing and washing purposes.

By 1970 the villagers had had enough. Representatives from 26 villages gathered and memoranda were sent to all the concerned authorities. When there was no response, the villagers organised a morcha to the site of the earthen dam constructed across the river by the factory and pressed their grievances before the District Collector. The factory agreed to install a waste treatment plant and the movement petered out.

In 1973 a team from the Indian Institute of Technology at Kanpur surveyed the area and discovered that milk yields had gone down, incidence of foot infections had gone up, death rates of cattle due to pollution were still quite pronounced, and there was reduction in the birth of calves. Fish had completely disappeared from the river. The team made some attempt to publicise their findings but the paper mill authorities pre-empted them. A temple was built and Hanuman mandals organised to sing bhajans; booklets of bhajans, musical instruments, clothes for children, exercise books, and blankets were distributed free.

Recently, the paper mill got much mileage out of a visit by an international team to its waste treatment plant which declared it to be one of the best of its kind. Yet the Sone still flows coffee-coloured, lethal to cattle and people, with not a single fish in its "treated" water.

Gwalior Rayons, Mavoor

The story of the Orient Paper Mills at Amlai has been repeated at Mavoor in Kerala by the Gwalior Rayons unit there. Gwalior Rayons is yet another Birla enterprise. But unfortunately for the factory's management, it has had to deal with an educated and aroused populace in contrast to the illiterate tribals of Anlai.

The Mavoor unit began production in 1958, making full use of cheap raw materials available in the vicinity. It converted the once-clear Chaliyar river into a black cess-pool. Fish died, bathing came to an end, skin infections spread, and crops started withering. In 1963, the people rose in protest. The management promised to discharge effluents directly into the sea through a 20 km long pipeline by 1966 and to dig wells in the affected villages. But these promises were soon forgotten.

The people organized protests in 1965, 1967, 1968 and 1973. In 1974, the State Government called a tripartite meeting of the people, the factory management and the newly formed Kerala State Water Pollution Control Board. The management agreed to discharge the treated effluents at Chungapalli, a brackish water stretch seven km downstream from the factory. Several years passed by and the factory did nothing.

In 1978-79, a team sponsored by the Kerala Sastra Sahitya Parishad (KSSP) conducted a study to determine the effects of pollution. Its report concluded that "The present arrangements for the treatment of the effluents are absolutely inadequate. The problem of pollution persists in the area mainly because of the callous indifference of the factory-management to employ the already available know-how for effluent treatment".

After waiting five years for Gwalior Rayon to implement the 1974 agreement, a massive agitation was launched in the summer of 1979. People gathered in thousands and destroyed a bund erected by the Company to protect its water intake. Forced by its own need for clean water, the Company laid the pipeline to Chungapalli in record time. But it was a poor job, leaking effluent throughout its length, and the effluent was more toxic now because waste water treatment had been virtually stopped.

A fresh furore arose in the villages affected by the new pipeline. The State Water Pollution Control Board finally succeeded in forcing Gwalior Rayon to repair the leaky pipeline. "Inspite of all this, under the cover of one pretext or other, the effluent continued to flow through the old pipeline, and sometimes directly without treatment", charged the KSSP in a review of the situation.

In late 1979, reports of the detection of mercury in the effluent caused alarm in the region. Though the company denied the reports, they were confirmed by the State Minister of Health and the Water Pollution Control Board. In November 1981, the Board sued Gwalior Rayon for discharging its effluent through illegal outlets and dumping it into the Chaliyar without proper treatment. The Kerala High Court recently passed severe strictures against the Company.

Earlier this year, a study commissioned by the Department of Science and Technology confirmed the presence of lead and other heavy metals in amounts exceeding the prescribed levels for the effluents. The Company's response was to take out half-page advertisements in various newspapers denying most of the charges. "We are doing the best we can to treat the effluent but the board and the villagers are unsympathetic," protests Mr R.N. Saboo, the company's Joint President. But dead fish still float down the Chaliyar.

A Repetitive Pattern

The contrast between the abandoned struggle against the Orient Paper Mill and the continuing campaign against the Gwalior Rayon factory at Mavoor, highlights the impact of an educated populace and the role of voluntary organizations. The people of Mavoor and the surrounding villages admit that the support of the KSSP has been vital in persuading government agencies to act against the company. In other parts of the country, however, voluntary agencies are still not very active.

POLLUTION CONTROL AND GOVERNMENT

Ecosystems may not be well understood yet, but specific treatments for specific forms of pollution are known and have been experimented with for many years.

Pollution Treatment

Sewage treatment has a long history and experience behind it. In 1977 Central Board for the Prevention and Control of Water Pollution, after a survey of pollution in Delhi, suggested a three-phase procedure for treating the untreated waste water of 515,000 kilolitres per day (53.6 per cent of the total waste water).

In Phase I it has suggested that at least five of seven major drains which discharge directly into the Yamuna and the two drains which discharge into the Agra Canal be chlorinated. This would cost Rs 40 lakhs. Phase II consists of low cost wastewater treatment systems being installed at the drain outfalls to treat the water to conform to the prescribed effluent standards. This would cost about Rs. 15 crores and take 2-4 years to implement. Phase II provides for the eventual diversion of the discharge of wastewater from the seven major drains through appropriate sewerage system followed by wastewater treatment. Such a pollution control programme would require Rs 50 crores and 5-7 years to implement.

Treated sewage can be used for irrigation and pisciculture. It is only when pollution levels go beyond specified threshold levels that the waste water can no longer be used for productive purposes.

The treatment of industrial wastes too is well-known. Earlier waste treatment equipment was available only from foreign companies, but now many Indian firms have entered the field and foreign exchange is no longer a limiting factor. In addition to effluent treatment, proper site selection can also help to ensure that polluted wastes do not reach drinking water sources, rivers and oceans.

Lately, there have been several investigations on the use of water hyacinth (*Eichhornia crassipes*) for waste treatment purposes. This weed is considered a nuisance because of its rapid growth and spread. It chokes waterways, hampers navigation, creates conditions suitable for the breeding of mosquitos, reduces the yields from paddy fields when it invades them, and is difficult if not impossible to eliminate. It has a high evapotranspiration rate which causes serious water losses (7.8 times higher than normal surface losses). Researchers have demonstrated that when grown in waste water it significantly reduces the BOD, the COD, and suspended solids. Harvested water hyacinth is also claimed to be a good source for high quality protein, vitamins, and minerals; as a nutritive cattle supplement; for organic soil supplement in the form of humus, and, for biogas plants.

Yamuna : Delhi's open Sewer

The Yamuna river traverses a distance of 48 km through the Union Territory of Delhi. Two-thirds of Delhi's water supply is obtained from this river, at Wazirabad (64.4 per cent) and Okhla (2.3 per cent). Out of an estimated consumption of 1200 million litres per day (Mlpd), almost 80 per cent, 960 Mlpd, is returned as waste water. The capacity of Delhi's sewage treatment plants is grossly inadequate — only 46.4 per cent of waste gets partial or full treatment. The rest, 515 Mlpd, finds its way into the Yamuna, through the city's 17 open drains.

Almost 96 per cent of Delhi's liquid waste is domestic sewage. Only 359 industrial units out of the 3329 in the capital city generate liquid wastes. The majority are small-scale factories.

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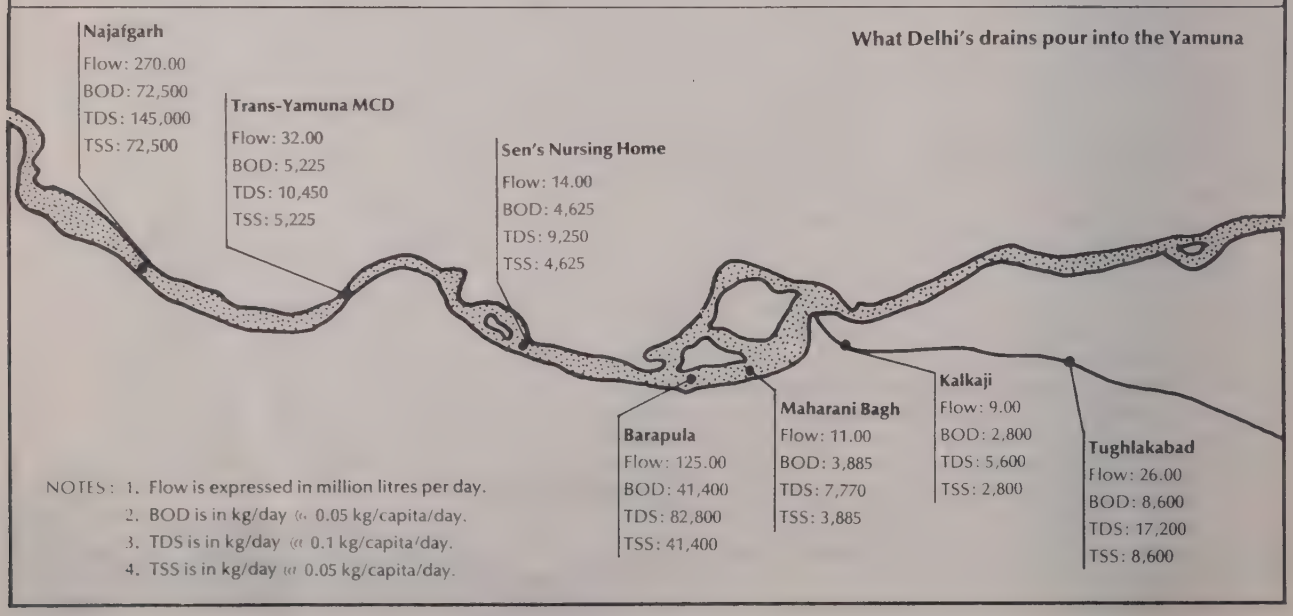

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In keeping with its orientation towards development alternatives, the KSSP has slowly become a powerful campaign organisation. One KSSP team studied the pollution of the Cheliyar river caused by a rayon factory owned by the Birlas. The local people had agitated but to no avail. A Parishad team sneaked into the factory to see if anything was being done to control pollution. The KSSP then organised the local people, picketed the factory and forced its closure. The effluent is now being dumped at a distant site but the factory consistently refuses to set up a treatment plant.

Relationships with even sympathetic political parties and trade unions have been strained at times. When the KSSP found that the scientific community was not prepared to oppose the construction of the hydroelectric dam that would destroy large tracts of the Silent Valley—home of rare and genetically rich evergreen rain forests—it initiated a public campaign which became an environmental *cause celebre*. The State Electricity Board and its unions criticised the Parishad, and so did the ruling State Government led by the Communist Party of India (Marxist). Its party line is to dub environmental concern in developing countries as a ruse of the West to keep developing countries industrially backward. KSSP continues to work closely with trade unionists and politicians but is not afraid to take up popular campaigns to raise mass consciousness.

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Can Kerala's science movement be duplicated elsewhere? Many attributes of KSSP are rooted in Kerala's unique past and present. It has seen a chain of social, political and religious movements over the last century. A Gandhian movement for setting up village libraries across the State started in the '40s, resulted in the establishment of over 9000 libraries. These libraries have become centres of intense cultural and intellectual activity in the villages. Today, the State's literacy rate of 70 per cent is the highest in the country.

Keralites are habitual readers and encourage their children to do the same. Church activities—because of the large Christian population in the State—have also contributed to social upliftment of the lower castes. Consistent political activity has given the poor a feeling of self-respect and a desire to learn.

Nevertheless, interest is growing in other States of India to duplicate KSSP's efforts despite the social, economic and political differences. In 1978, KSSP started work in Karnataka. Another effort is being made in Maharashtra.

Evading responsibility

With all this technical know-how and expertise available, why is water pollution not being controlled? There are many reasons and they simply underscore the non-technical complexities of environmental control.

One of the most common arguments given for delay in pollution control measures is that the technology for control is not available or is too expensive. This is utter nonsense. Rs. 2.7 million is not too much for the Zuari Agro Chemicals with a capital investment of Rs. 560 million. The Orient Paper Mills, with an annually declared profit around Rs six crores, can also spend Rs 12 lakhs on pollution control. The Government that is spending Rs 700 crores to hold the Asian Games in New Delhi, can also find Rs 50 crores for the city's sewage treatment plant. All these expenses pale in comparison with the costs of ill-health of the affected communities, the dead fish year after year, and the thousands of hectares of land laid waste by effluents.

The "production versus pollution" debate occupies a central place in all these conflicts. Production units argue that if they have to obey all the environmental regulations, then they will no longer be productive and will have to close down, rendering thousands of workers jobless. Environmentalists argue back that if pollution is allowed to continue, many more will become jobless.

Technical experts often get divided on the scientific issues. The Goa Public Health Laboratory tests were rejected

by the Zuari Agro Chemicals Limited because tests done by the National Institute of Oceanography did not reveal any significant pollution. Such "clean chits" from institutes of national importance provides enough ammunition to Company authorities to delay action for years.

The most important reason, however, is that those who create pollution form immensely powerful political lobbies. When their interests are threatened, they spread large amounts of misinformation, buy technical experts to support their case, threaten government officials with the spectre of halting production, offer all kinds of bribes and delay action until the last possible moment. In Maharashtra, a Chairman of the State Water Pollution Control Board resigned in disgust when his efforts to enforce the Water Pollution Control Act were frustrated by politicians.

Even when forced by circumstances to install treatment plants they find it far more convenient to bypass these plants and throw the effluent directly into rivers, keeping the plants as models to exhibit to VIPs and uncomfortable committes and enquiries. The actions of Gwalior Rayon in Mavoor are a case in point.

Legislative measures

The history of legislation to prevent water pollution is quite old. A provision in the Criminal Procedure Code of 1898 (section 133) empowered District Magistrates to pass an order to prohibit a factory from discharging noxious effluents into a river, which might be injurious to the health of the community using the water. When faced with people's protests, all District Magistrates can act under this provision even today.

As the pace of urbanization grew, the British rulers in India took steps to maintain minimum standards of hygiene and sanitation in large cities like Bombay, Calcutta, Madras and Kanpur, and in cantonment areas to protect their soldiers. Various standards, building codes, Nuisance Acts, Municipal Acts and Factory Acts were laid down by them. All of these were inherited by independent India.

Other laws also became available after independence for use by the affected people. The Factories Act of 1948 authorises State Governments to make rules prescribing the arrangements required for the disposal of wastes and effluents (Sec 12). The Calcutta Municipal Act of 1951 specifically prohibits the fouling of water in carrying on trade and manufacture (See 441). Uttar Pradesh became the first state to set up Effluent (Control) Board in 1955. In 1970, Maharashta adopted a Water Pollution Control Act, which served as a model for the national legislation enacted four years later.

The Prevention of Water Pollution Act 1974, is therefore, not the only remedial measure available. It is only the most comprehensive. It provides for inspection and control in a coordinated manner but it has not achieved much. Many of the State Pollution Control Boards are inactive. Others prefer to reason and persuade, generally fruitlessly, rather than enforce. Even the Central Water Pollution Board has not had much success. As of 1981, out of a hundred odd court cases it initiated, only a few of the offenders could actually be penalised. The rest were able to escape through the numerous loopholes the law offers.

Many industries have chosen to disregard the instructions of the various Boards. Advisory Committees to the Government have been quick to recognise this. In 1982, one of these committees stated, "It is never in the economic interest of a polluting industry to fully treat the effluents. In addition, great deal of wastage may be involved in each industry of an industrial complex separately treating its own effluent. A more efficient system would be for the Government to receive the effluents, to monitor their quality, to charge the industry for the treatment called for, and to organize treating the effluent."

There is nothing that the industry would like better than doing nothing about pollution. Some of them are even asking for subsidies. When the Tamilnadu government threatened to close down all tanneries unless they treated their effluents or fully paid the Government to do so, the Leather Export Promotion Council, representing the leather industry, persuaded the Government to defer its decision until some agreement could be reached on sharing of the expenses.

"Give an inch and they'll take a mile," goes the common saying. Inch by inch the administrative machinery of pollution control is retreating. Many people believe that pollution control will never succeed unless the Government has adequate political will. But political will does not come alone from the State, it comes also from the people. Wherever they have organised protests and challenged the polluters, there they have pushed the State forward, to act.

FORESTS

POLLUTION CONTROL AND GOVERNMENT

Ecosystems may not be well understood yet, but specific treatments for specific forms of pollution are known and have been experimented with for many years.

Pollution Treatment

Sewage treatment has a long history and experience behind it. In 1977 Central Board for the Prevention and Control of Water Pollution, after a survey of pollution in Delhi, suggested a three-phase procedure for treating the untreated waste water of 515,000 kilolitres per day (53.6 per cent of the total waste water).

In Phase I it has suggested that at least five of seven major drains which discharge directly into the Yamuna and the two drains which discharge into the Agra Canal be chlorinated. This would cost Rs 40 lakhs. Phase II consists of low cost wastewater treatment systems being installed at the drain outfalls to treat the water to conform to the prescribed effluent standards. This would cost about Rs. 15 crores and take 2-4 years to implement. Phase II provides for the eventual diversion of the discharge of wastewater from the seven major drains through appropriate sewerage system followed by wastewater treatment. Such a pollution control programme would require Rs 50 crores and 5-7 years to implement.

Treated sewage can be used for irrigation and pisciculture. It is only when pollution levels go beyond specified threshold levels that the waste water can no longer be used for productive purposes.

The treatment of industrial wastes too is well-known. Earlier waste treatment equipment was available only from foreign companies, but now many Indian firms have entered the field and foreign exchange is no longer a limiting factor. In addition to effluent treatment, proper site selection can also help to ensure that polluted wastes do not reach drinking water sources, rivers and oceans.

Lately, there have been several investigations on the use of water hyacinth (*Eichhornia crassipes*) for waste treatment purposes. This weed is considered a nuisance because of its rapid growth and spread. It chokes waterways, hampers navigation, creates conditions suitable for the breeding of mosquitos, reduces the yields from paddy fields when it invades them, and is difficult if not impossible to eliminate. It has a high evapotranspiration rate which causes serious water losses (7.8 times higher than normal surface losses). Researchers have demonstrated that when grown in waste water it significantly reduces the BOD, the COD, and suspended solids. Harvested water hyacinth is also claimed to be a good source for high quality protein, vitamins, and minerals; as a nutritive cattle supplement; for organic soil supplement in the form of humus, and, for biogas plants.

Yamuna : Delhi's open Sewer

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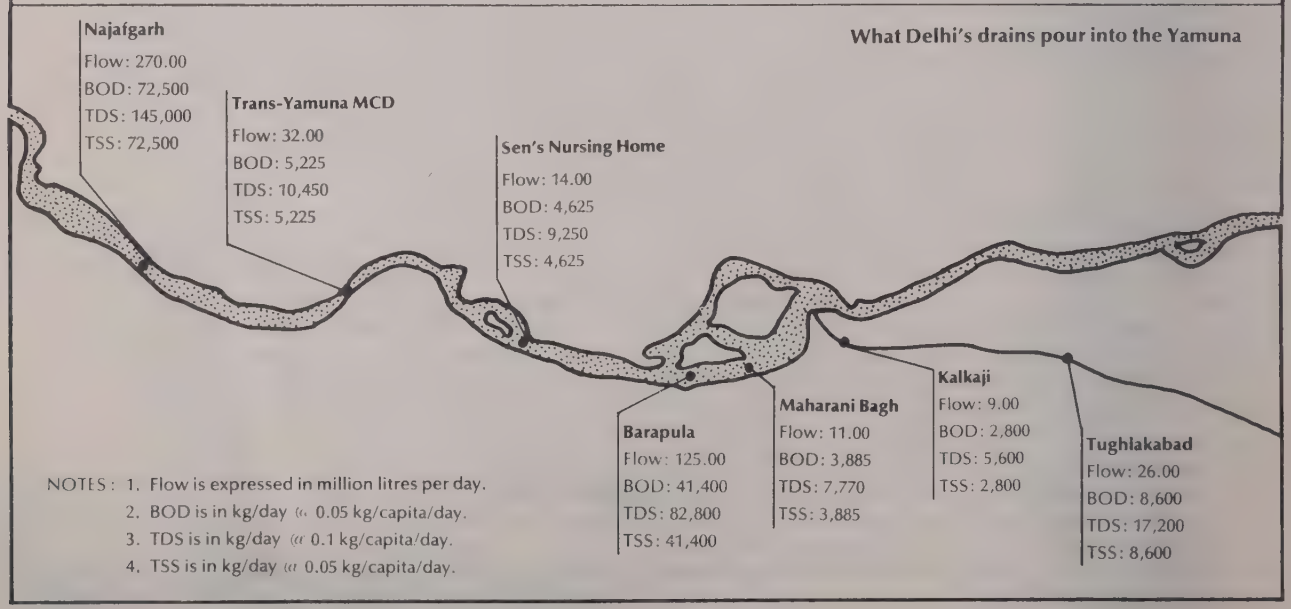

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Cherrapunjee — the wettest spot on earth and once covered with lush subtropical forests — is today a barren area.

Though the forest department controls 23 per cent of India's total area, only about 10-12 per cent has adequate tree cover.

Over one million hectares of forests are cut every year, according to unofficial guesstimates. Some 0.15 million hectares of forests are lost to development projects annually.

Nearly one per cent of the land area of Himachal Pradesh has been stripped off its forest cover every year over the last 25 years. By 1990, 1.4 lakh trees will be cut every year just to make apple crates.

Tribals in Bihar are resisting the State Government's policy of replacing natural forests, with monoculture plantations. In a police firing in the township of Goa in September 1980, 13 tribals were killed and over 200 arrested.

The destruction of bamboo forests by the paper mills of Southern India has meant considerable hardship for the local basket weavers; their earnings have fallen and many now are forced to steal their daily bamboo supply.

3

FORESTS

There is probably no other area of India's environment that has been more viciously attacked and destroyed in the last century than the country's forests. According to official statistics released by the Forest Department, India lost between 1951 and 1972 3.4 million hectares of forest lands to dams, new crop lands, roads and industries, which means an annual rate of deforestation of about 0.15 million hectares.

But many observers place the current rate of deforestation at well over one million hectares every year. The official figures of deforestation include those lands that have been taken away from the forest department through official channels. They do not include vast areas, adjacent to dams and industries, that are under the control of forest departments but whose tree cover has been totally destroyed. These figures also do not include lands where illegal felling has been taking place or even those lands which have been deforested because of the forest departments' own timber contracts.

Forest department statistics have repeatedly pointed out that approximately 23 per cent of the country's total area, that is, 75 million hectares, are classified as forest lands. But this again is a misleading statement. It simply means that this vast area is under the control of forest departments; there is no guarantee that it has tree cover. Prime Minister Indira Gandhi, while addressing the Central Forestry Board in 1981, frankly admitted that only half of the official forest lands are under adequate tree cover. A report of the National Committee on Environmental Planning also clearly states that no more than about 12 per cent of the country's total land surface is under adequate tree cover. An aerial survey conducted by the Indian Space Research Organisation in 1974 in Anantapur district (Andhra Pradesh) found that many reserve forests in the district had no trees at all.

Table 1. Forest area lost between 1951 and 1972

Purpose	Area (in thousand ha)
River valley projects	401
Agricultural purposes	2,433
Roads and communications	55
Establishment of industries	125
Miscellaneous	388
Total area lost	3,402

This represents an average annual loss of 155,000 hectares.

Source: Forest resources of tropical Asia, FAO, 1981.

In addition, a recent report prepared by the International Union for the Conservation of Nature and Natural Resources (IUCN) says that India has lost nearly 2.5 million hectares of mangrove forests over the last 80 years. These remarkable forests can grow on marginal lands and survive waterlogging, soil infertility, salinity, and heavy winds. But they have not been able to face the onslaught of human beings.

All this is particularly depressing because the National Forest Policy of 1952 had set a national target of bringing at least one-third of India's land area under forest cover. As afforestation programmes have never been attempted on the scale that deforestation is taking place, the country has progressively moved away from this national target.

Between 1951 and 1980, the total area that was brought under afforestation schemes amounted to a total of 3.18 million hectares, of which 2.2 million hectares (69 per cent) were covered by plantations for industrial purposes, only 0.39 million hectares (12 per cent) for fuelwood purposes, and 0.6 million hectares (19 per cent) for soil and moisture conservation purposes. According to the forest departments' estimates of tree survival rates ranging from 50 to 70 per cent (which are considered highly optimistic by most observers), the total afforested area in the country during the three decades would not amount to more than 2.07 million hectares.

A Warning

A 1981 FAO report on Forest Resources of Tropical Asia clearly warns that the region is faced with a serious decrease in its forest stock. "There is no evidence to predict that the great variety of forest services and functions, such as harbouring of wildlife, stabilisation of soil and of water and climatic regimes, can be reestablished in the foreseeable future," says the report.

The consequences of this excessive deforestation are increasing floods, soil erosion, heavy siltation of dams built at an enormous expense and changes in microclimate: in other words, a progressive depletion of the country's ecological bank, driving it incessantly towards bankruptcy. Flood damages alone now average Rs 1000 crores every year.

What is worse in human terms is the increasing denial to a large section of the country's population of forest products like firewood, which are vital for human survival. The FAO report warns that there is already an acute scarcity of firewood in the mountainous regions of northern India. Deficit situations exist in the Indogangetic plain and in southern India. The remaining areas of India, which are not deficit in firewood at the moment are also expected to face a shortfall in their energy needs by 2000. A shortfall of 182

Table 2. State-wise forest area in 1980

State/Union Territory	Forest area (Thousand hectares)	Forest area as percentage of total area	Per capita forest area (hectares)
Andhra Pradesh	6,409	23.15	0.13
Assam	3,071	39.11	0.16
Bihar	2,923	16.81	0.04
Gujarat	1,952	9.96	0.10
Haryana	164	3.71	0.01
Himachal Pradesh	2,119	38.06	0.51
Jammu & Kashmir	2,189	9.85	0.37
Karnataka	3,787	19.75	0.11
Kerala	1,112	28.62	0.04
Madhya Pradesh	15,389	34.75	0.29
Maharashtra	6,408	20.82	0.11
Manipur	1,515	67.75	1.06
Meghalaya	855	38.02	0.66
Nagaland	288	17.42	0.41
Orissa	6,767	43.44	0.25
Punjab	243	4.83	0.02
Rajasthan	3,491	10.20	0.11
Sikkim	260	35.62	1.04
Tamil Nadu	2,179	16.75	0.05
Tripura	593	56.58	0.29
Uttar Pradesh	5,139	17.46	0.05
West Bengal	1,184	13.48	0.02
Andaman & Nicobar	714	86.13	3.90
Arunachal Pradesh	5,154	61.67	8.26
Chandigarh	Negligible	Negligible	Negligible
Dadra & Nagar Haveli	20	40.82	0.23
Delhi	Negligible	Negligible	Negligible
Goa, Daman & Diu	105	27.56	0.09
Mizoram	713	33.81	1.46
Pondicherry	Negligible	Negligible	Negligible
Lakshadweep	Negligible	Negligible	Negligible
TOTAL	**74,743**	**22.73**	**0.11**

million cubic meters of firewood is predicted by the report by 2000, even if all planned plantations take place. Millions of women who have to collect this firewood daily are condemned to a grim future.

When faced with the inevitable result of so many years of destruction, the usual response of the forest departments is to blame someone else. Many types of people have been blamed for forest destruction in India, including nomads and graziers, tribal populations and shifting cultivators and ordinary village women who have to collect their daily fuelwood needs.

Problem of overgrazing

The problem of grazing is acute in India, the FAO report points out. In 1975 India had about 15 per cent of the world's cattle, 46 per cent of its buffaloes, 17 per cent of its goats and four per cent of its sheep. "Grazing intensity is high in most of the forest areas of India. Incessant lopping of graziers has reduced vast forested areas to an unstable low scrub in the Himalayan zone. In addition to depletion of vegetative cover trampling by cattle is hardening the soil, preventing forest regeneration and causing soil erosion in several parts of the Indian subcontinent." But the report also points out that the extension of irrigated and cultivated land areas is leading to a decrease in land available for grazing and in the absence of attractive employment opportunities, the graziers are being forced into a heavy reliance on grazing in forest areas and consequent degradation of the forests.

The reasons for such degradation of forests are first, a failure to meet the basic needs of rural people, and second, the exploitation of forests for urban markets. As people living near the forests are denied legitimate access to forests for satisfying their basic needs for fuelwood, building poles, fodder etc, they have had to resort to illegal and unorganised fellings or overgrazing. Shifting cultivation does affect aforest area of 9.5 million hectares (see table) but it is mainly restricted to northeastern states, namely Arunachal Pradesh, Assam, Nagaland, Manipur, Meghalaya, Mizoram and Tripura. In these states it is only one of the several causes of deforestation. Shifting cultivation is also practised in Orissa and Andhra Pradesh but the dependence on this form of cultivation is partial. In Orissa, eight districts out of 22 have shifting cultivation. Unauthorised shifting cultivation is also practised in Bihar, Kerala, Karnataka, Madhya Pradesh, Maharashtra and Sikkim but the population is only marginally dependent on shifting cultivation and the extent is not significant.

The maximum blame for deforestation rests squarely on the management policies of forest departments. "Forestry is not, in essence, about trees," says a leading forestry expert. "It is about people. It is only about trees so far as they serve the needs of the people". But in India, forests have never been reserved for the people.

Short-sighted policies

The origin of the current crisis lies in the short-sighted forest policies initiated by the British. The only interest that the former colonial rulers had in the forests of India was in their revenue earning capacity. Unfortunately, even after independence, the same commercial outlook has remained the most dominant theme within the forest departments. In 1980-81, India earned Rs 464 crores from its forests, with five states Madhya Pradesh (Rs 139 crores), Maharashtra (Rs 52 crores), Karnataka (Rs 46 crores), Kerala (Rs 31 crores) and Orissa (Rs 25 crores) accounting for 64 per cent of this revenue. In four States, the forest revenue was almost equal to or over 10 per cent of the State's total revenue in 1980-81. These States were: Tripura (13.15 per cent), Madhya Pradesh (12.5 per cent), Himachal Pradesh (8.37 per cent) and Jammu and Kashmir (8.31 per cent).

The forest departments, naturally, do not accept this charge, pointing out that they follow "working plans" designed by leading foresters on the principles of scientific tree-feeling. Contractors are supposed to cut trees only according to authorised working plans, which normally allow only the incremental growth to be felled without harming regeneration potential of the forest. The foresters, however, conveniently forget to point out that these schemes work only on paper. Huge sections of the forests are lost to illegal felling which were never included in the working plans.

Table 3. State-wise contribution of forest revenue in 1980-81

STATE	REVENUE (million rupees) All Sources	Forests (expected)	Percentage contribution of forests
Andhra Pradesh	109.288	2.609	2.38
Assam	30.373	1.125	3.70
Bihar	87.465	1.471	1.68
Gujarat	94.750	1.128	1.19
Haryana	43.332	0.159	0.36
Himachal Pradesh	19.288	1.616	8.37
Jammu & Kashmir	22.573	1.878	8.31
Karnataka	91.244	4.600	5.04
Kerala	59.129	3.178	5.37
Madhya Pradesh	111.488	13.944	12.50
Maharashtra	192.197	5.220	2.71
Manipur	8.456	0.024	0.28
Meghalaya	6.636	0.088	1.32
Nagaland	9.543	0.050	0.52
Orissa	53.690	2.521	4.69
Punjab	54.472	0.404	0.74
Rajasthan	71.659	0.651	0.90
Sikkim	3.501	0.032	0.91
Tamil Nadu	98.266	1.125	1.14
Tripura	8.555	1.125	13.15
Uttar Pradesh	162.234	2.030	1.25
West Bengal	112.373	1.423	1.26
TOTAL	1,450.518	46.401	3.19

In Uttar Pradesh, at least a quarter of the forest area has been lost to illegal felling and the State's Forest Minister, Nirbhay Singh, admits that even today illegal felling is rampant in various districts of the State.

It is amazing that the country's premier forest institution, the Forest Research Institute in Dehra Dun, has not conducted a single study on the total impact of deforestation. Its major achievement, the institute proudly claims, is in the field of forestry product research, a need primarily of the forest-based industry.

Since independence a number of forest-based industries have emerged and expanded and forestry practices have inevitably become linked with the consumption demands of these industries. The present level of production of industrial wood is about 10 million cubic metres and expected production in 1990 is about 14 million cubic metres. The current demand is about 24 million cubic metres. In an attempt to meet this shortfall, forest departments have consistently overlooked the rural demand for forest products, and in order to keep the rural people away from the forests a kind of police attitude has been developed within them. The proposed Forest Bill is an excellent example of such prevailing attitudes.

As Madhav Gadgil, a leading botanist at the Indian Institute of Science in Bangalore points out, the current economic situation is such that there is virtually no section of the country's population—the local population, the Government or the industry—which has any personal stake left in the preservation of forests. "The local population is not bothered about preserving forests because it earns more if it steals the wood instead of working for low wages. The industry is interested only in immediate profits. The forest bureaucracy has neither responsibility nor accountability."

WESTERN HIMALAYAS

The rate of depletion of forests in the Himalayan ranges, which represent a quarter of India's forest reserves, is so great that this mighty mountain chain could become barren by the first half of the next century. From Kashmir to Assam the story is the same. Below 2000 metres there are literally no forests left.

In the middle Himalayan belt, which rises to an average height of 3000 metres, the forest area, originally estimated as being a third of the total area, has been reduced to a mere six to eight per cent.

"Forest depletion is amongst the most urgent problems of the Himalayas that call for immediate remedial measures", says a study of ecodevelopment in the Himalayan

Table 4. Financial working of forest departments, 1980-81

State/Union Territory	Revenue from forests	Expenditure (Normal & Plan)	Surplus (+) or Deficit (–)
	Million rupees		
Andhra Pradesh	260.914	148.249	+ 112.665
Assam	112.455	63.530	+ 48.925
Bihar	147.113	72.648	+ 74.465
Gujarat	112.801	129.755	– 16.954
Haryana	15.897	30.933	– 15.036
Himachal Pradesh	161.585	130.645	+ 30.940
Jammu & Kashmir	187.807	133.633	+ 54.174
Karnataka	460.000	256.800	+ 203.200
Kerala	317.836	76.788	+ 241.048
Madhya Pradesh	1,394.412	889.317	+ 495.095
Maharashtra	521.953	269.625	+ 252.328
Manipur	2.393	10.560	– 8.177
Meghalaya	8.756	0.211	+ 8.545
Nagaland	5.012	25.455	– 20.443
Orissa	252.067	85.613	+ 166.454
Punjab	40.440	52.916	– 12.476
Rajasthan	65.134	150.251	– 85.117
Sikkim	3.156	10.659	– 7.503
Tamil Nadu	112.542	91.763	+ 20.779
Tripura	112.469	92.471	+ 19.998
Uttar Pradesh	203.000	233.318	– 30.318
West Bengal	142.338	131.671	+ 10.667
Andaman & Nicobar	38.025	42.285	– 4.260
Arunachal Pradesh	38.181	23.330	+ 14.851
Chandigarh	—	—	—
Dadra & Nagar Haveli	2.259	1.733	+ 0.526
Delhi	0.053	0.015	+ 0.038
Goa, Daman & Diu	6.688	10.858	– 4.170
Mizoram	0.284	3.246	– 2.962
Pondicherry	—	—	—
TOTAL	**4,725.560**	**3,178.278**	**+ 1,547.282**

NOTE : These are provisional figures.

When the trees go, the mountains will crumble. A killer landslide buried the hamlet of Kranla, on the Jammu-Srinagar highway, in a rocky grave. (India Today/Bhawan Singh)

region conducted by the Planning Commission in March 1982.

Jammu and Kashmir

The situation in Jammu and Kashmir has gone so far that even the Chief Conservator of Forests of the State had to warn in a circular sent out early this year that the forests of the State were in a "worse condition" than when conservation began 100 years ago. He stressed that the deterioration had set in after 1947. The forests were not regenerating, growing stocks had dwindled, and some forests had been totally encroached upon and destroyed.

The official called for a reassessment of the policy of cutting trees for commercial purposes. He also blamed faulty resin-tapping for the drying and eventual death of thousands of chir pine trees. Rs 150 crores would be needed over the next 20 years, in his view, to rehabilitate the chir forests. The forested area in the State is now a mere 9.8 per cent of the total geographical area — that is 2.2 million hectares.

According to Sunderlal Bahuguna, who took a foot march through the State, there are three main reasons for deforestation there. He rates the commercial exploitation of forests as the most powerful factor. When this began about hundred years ago, it was limited to river valleys where it was easy to fell logs and float them down the rivers. With the extension of roads, even remote forests became more accessible. Before the days of large-scale commercial forestry, the practice was to remove over-mature trees. These were then available in large numbers. Today large-size trees are rare and the only specimen of what forests in the State were once like is seen in the Udil forest in Jammu province where trees with girths of 12 to 20 feet can be found.

The extent and growth of commercial forestry in the State can be assessed from the fact that whereas in 1947 the income from forests was Rs 85 lakhs, in 1980-81 it had grown to Rs 34 crores.

Due to the importance accorded to the commercial exploitation of forests, forest lessees can operate within virgin forests withour proper supervision, says Bahuguna. Saw mills have been permitted to function even within remote forests. Bahuguna saw ropeways built to transport logs from remote virgin forests to the road. Cut logs were rolled down hillsides causing land erosion and triggering off landslides.

Another factor harming forests is the construction of roads without adequate soil conservation measures. Trees are felled and damaged and landslides caused by careless construction have eroded the land so permanently that trees cannot grow there any longer. Many roads become unusable as a result of this; the Daksum Chingaon road, for instance, which goes through 70 km of uninhabited area, remains open for only three months in a year. The rest of the time it is blocked either by snow or by landslides.

The heavy snowfall in J&K in the winter of 1979 damaged large forest areas, specially the young trees; removing damaged trees has kept the forest department occupied till today. But environmentalists point out that such damage is minimised when the forest is left untouched because the older trees can usually protect the growing, younger ones. "But when we disturb this and convert natural forests into monoculture timber fields, allowing the trees of only one age group to survive, they are victims of a calamity", writes Bahuguna in his report on Kashmir.

The State's chir pine forests have also been damaged by excessive resin tapping. The distillation of resin yields rosin and turpentine. Resin finds ever-growing use in the manufacture of plastics, synthetic rubber, explosives, adhesives, printing inks, pharmaceuticals, perfumes, varnishes, lacquers and soldering fluxes and cosmetics. Turpentine is widely used in the manufacture of camphor and as a thinner for paints and varnishes.

The trees are literally bled dry if the resin tapping is excessive. Consequently they weaken and break easily during storms. In 1981, windbroken trees provided 40,000 cubic metres of timber, which is higher than the prescribed annual yield of the J&K forests. "In J&K, so extensive is the resin tapping that the State forests are likely to be exhausted within 10 years", says Bahuguna. "The yield has come down from 50 kg to 3 kg per channel."

Diversion of tree species for forest-based industries is creating shortages for the local people. For instance, in Kashmir fast growing willows were the traditional providers of fuelwood. Now they are being used for the sports goods industry and the people are turning to other trees for fuelwood. Its demand is increasing rapidly; Srinagar alone consumes 46,000 tonnes of fuelwood per year.

The J&K Chief Conservator of Forests has draw attention to the acute shortage of firewood that is being felt in the Kashmir valley. He also predicts that soon the State will face a water famine because the State's springs and streams are drying up. He says the hydel dams that exist in the State would then become "monsoon dams", near dry the rest of the year. Landslides — the result of deforestation — are also covering up valuable cropland.

Himachal Pradesh

The situation in Himachal Pradesh is not much different from that of Jammu and Kashmir. Even as late as the mid-1950s, 38.5 per cent of the State's land area was covered with forests. Even though this itself was much below the recommended ratio of 60 per cent for mountainous regions, tree-felling went on unabated. A recent study of the HP Government has concluded that the forest cover has fallen to a bare 18 per cent. In other words, nearly one per cent of the land surface in HP has been stripped of its forest cover every year in the last 25 years. The Kulu Valley, for instance, once a picturesque sea of deodars some 150 feet in height and 10 feet or more in girth, is now almost bare.

The forests have consistently fallen victim to the revenue hunger of this poor State. The revenue from timber has gone up rapidly from Rs 9.27 crores in 1977-78 to Rs 16 crores in 1980-81. Out of the 0.56 million cubic metres of timber felled in 1980-81, 85 per cent was used for commercial purposes, including about 20 per cent for making apple packing cases.

As HP produces more than a third of the total apple production in the country, about 2.5 million tonnes per annum, the need for making packing cases for the apples makes a considerable dent on the State's forests and is probably the most serious problem in the short term. Apple growing is a profitable business; so many private landowners have cleared forested slopes to make way for apple orchards. As it takes five to seven years for an apple tree to bear fruit, farmers use the interim to grow potatoes on the slopes.

Tree by tree, row by row, a forest of magnificent deodars is about to disappear. The Kulu Valley, once a picturesque sea of deodars, is almost bare now. (UNICEF/Purnima Rao)

This, unfortunately, becomes a major cause for soil erosion.

To assist the apple growing industry, the Government has given concessional timber rates to packing case manufacturers. They are allowed to set up saw mills inside forests and their usual practice is to clear-fell the area. In this way 1.5 lakh cubic metres of timber are used each year, and by 1990 the Government estimates that this demand will rise to four lakh cubic metres and require the felling of 1.4 lakh trees every year.

Using precious wood for making packing cases at a cost of Rs 6-7 per case poses not only a serious threat to the environment but also constitutes an enormous economic waste. If the same wood was used to make furniture or quality paper, the value added would probably be hundred times more. There never was a more urgent need to find a cheap and viable substitute for wood.

As in other States, the major cause of deforestation has been the private contractor system. Once the contractor is in the forest there is no way of stopping him from felling five or even 10 unmarked trees for every one that has been marked for felling. The local forest guard can easily be bribed off with a bottle of country liquor. Taking into account the claim of the forest department that it has been planting 20 million trees a year with a survival rate of 25 per cent at the least, a recent report in the "Times of India" concluded that either these afforestation figures are an eyewash, or upto 30 or 40 trees are felled illegally for every tree that is cut down legally. Otherwise it is impossible to achieve the rate of deforestation that is now evident from government statistics.

Timber is indeed big business. The Himachal Pradesh Government earns about three-quarters of its forest revenue from royalties on the commercial felling of about 200,000 trees. This amounts to about Rs 600 per tree. Against this the timber contractor is able to sell a medium-sized deodar tree in Amritsar for Rs 2000-2500.

Besides the tracts of forests cleared for agriculture and tea plantations, large areas of existing forests are threatened because of indiscriminate resin extraction from chir pine trees. Half-inch deep cuts are stipulated; instead tappers cut as deep as four inches. The width of the cuts should be only four inches. Instead it is common to find trees with cuts between 8 and 10 inches wide. Leave alone older trees, which are in this way literally bled to death, even young trees less than a foot in diameter have been tapped. Against a maximum of three blazes that a tree can stand, tappers are known to make as many as 10 blazes.

In two storms that hit the forests of Sirmur district this year, the forest department estimated that over 40,000 pine trees were destroyed. The lifespan of a pine tree is around 100 years. Most of the trees that fell had completed less than half their expected lifespan. In the Jamta range of Nahan forest division, the trees were broken about two feet from the ground, a clear indication of the damage caused by resin tapping.

As Sunderlal Bahuguna puts it: "Broad-leaved trees disappeared long ago from the Himalayan region. Now even the chir pines are going down before the rapacity of a man."

Many new forest-based industries continue to be encouraged. The hornbeam, a tree species used as fodder during the dry season, is now being diverted as a raw material for the bobbin-shuttle industry. The wood used to be earlier procured from the Assam forests. An industrialist has secured monopoly cutting rights for hornbeam in Himachal Pradesh for the next 20 years.

There are, however, signs that the State Government may be becoming more environmentally conscious. In 1980, the State Government informed the Centre that it wished to put a complete ban on all commercial felling for five years. That would save the three million mature trees felled legally every year and make illegal felling difficult. But it wanted the Central Government to make good the loss of revenue.

New Delhi did not accept this proposal but suggested instead that the revenue earned ought to be kept constant. The State Government accepted this proposal and felled 10 per cent fewer trees in 1980-81, yet its revenue from forestry went up that year. Contract felling was banned in nine out of the 27 forest divisions in 1980-81, and according to the "Times of India" report, the Government hopes to eliminate it from the remaining divisions by 1983. Police checkposts at all the 19 exit points from the State have also been rein-

forced to check timber smuggling. Since 1980, more than 250 arrests have been made for illegal felling.

The Government is also doing extensive replanting of coniferous forests, which, if successful, could cover half the State's land area by 2000. From 20 million trees every year, the forest department plans to raise the annual plantation rate to 70 million trees in 1984-85 and maintain it at that level for the rest of the decade. Ensuring that these trees survive will certainly pose a serious challenge to the State's foresters unless they can involve the local people.

They might just succeed, however, if they achieve this high rate of afforestation. "The chir pine has survived even in the most thickly populated Himalayan regions between 800 and 2000 metres, because the acidic content of its needles makes it unfit for fodder", says Bahuguna. "Villagers are also not fond of it because it depletes the soil."

Uttar Pradesh

With the control of malaria, the forests in the foothills of Uttar Pradesh were totally decimated during the 1950s. They have since made way for rich crop lands and today this erstwhile forest region constitutes the most prosperous agricultural region of the State.

Forests in UP are now mainly concentrated in the eight northern mountainous districts collectively knows as Uttarakhand. The Uttarakhand region covers about 53,123 sq km. Although about 37.45 per cent of it is under forest cover, about half of this forest area is degraded with poor tree density. The optimum density necessary for effective soil and water conservation is now found only in the remote valleys of the region. Nearly eight per cent of the total area is facing severe soil erosion and needs to be tackled on a priority basis.

"The destruction of forests in this ecologically sensitive region of the Himalayas is very unfortunate," says Chandi Prasad Bhatt, the originator of the Chipko movement. The region gives rise to the mighty tributaries of the Ganga, namely, Bhagirathi and the Alakananda. Much of the region is prone to landslides and soil erosion. Destruction of the forests leads to floods which have far-reaching effects in the plains.

The Alakananda witnessed an unprecedented flood in 1970. The entire village of Belakuchi was washed away by the swirling torrent of the river along with several bus loads of tourists. The flood affected a 400 km long area and washed away several bridges, hundreds of head of cattle and several lakhs of rupees worth of timber and fuel. The silt carried by the flood waters was so enormous that a 10 km stretch of the Upper Ganga Canal — which starts from Hardwar, some 350 km away from the upper reaches of the Alakananda — became blocked. Subsequent desilting operations took so long that western UP's farm output nosedived that year through lack of irrigation water. During 1978 the region witnessed massive floods again and down in the plains, every district of UP except one was affected by floods.

All over the region of Uttarakhand the old terror of tigers has been replaced by the even more awesome terror of floods and landslides. The Chipko volunteers have collected data on the deaths of human beings and animals from landslides every year after 1971. In 1971, 10 persons and 440 head of cattle perished. In 1978, the figures were 14 persons and 164 cattle. In 1979, they were 45 persons and 100 cattle.

Fuel scarcity

Fuel scarcity is now so acute that many women have to walk 1-15 km to get their daily fuel. The destruction of forests is also having a profound effect on the ecology of the region. It is now rare to find broad-leaf forests full of oak and rhododendron. Whenever afforestation programmes have been undertaken, they have been replaced by the chir pine. Both oak and rhododendron are now protected species. Chipko volunteers also claim that several glaciers have been receding regularly. The Gangotri Glacier has apparently receded about 600 metres between 1935 and 1976 and Pindari Glacier about three km in the last 130 years. The Bhyundar Glacier has also been receding regularly over the last century.

Beginning soon after the 1962 Indo-Chinese conflict, Indian engineers blasted a gigantic network of roads and communication facilities deep into the hills. In Chamoli district alone there are now 1100 km of motorable roads. This massive network of roads has opened up the area for further exploitation by forest contractors. Timber felling has taken place even way up in the sensitive valleys close to the Tibet border. Private contractors have indulged in the same rapacious practices of illegal felling as in other States of

Double jeopardy in the hills: forested hillsides are blasted to make roads, which then become the cause of soil erosion. (India Today/ Bhawan Singh)

India, regardless of the sensitive character of the region.

In almost all cases, the roads themselves have become major causes of soil erosion. The blasting that has taken place around Joshimath town, for instance, which is situated on an earlier landslide zone, has already posed a major threat to it. Even though a government committee has prohibited blasting in the area, it still continues for making new roads for a major hydro-electric project. As many as 22 hydro-electric projects are being proposed on the rivers of the Uttarakhand.

Pine graveyard

Sundarlal Bahuguna has also drawn attention to the destructive resin-tapping practices in the State. Quoting a recent report of a senior forest official of the State, Bahuguna points out: "The condition of Rana block in Yamuna forest division is most pitiable. We could see a large number of trees badly wounded with resin blazes on all sides. At some spots it seemed as if the area has been clear-felled". To Bahuguna, the region has become "a graveyard of pine trees".

Thousands of chir pine trunks can be seen littering the mountain slopes in Ranikhet, Nainital, Kasauni, Lansdowne and all along the route to the holy shrines of Gangotri, Yamunotri, Badrinath and Kedarnath. According to Bahuguna, the average number of trees broken by storms in the Tons forests division alone has been 30,000 every year since 1975.

As resin-tapping became an important source of profit for the State during the 1960s, working plans of forest divisions were changed to subserve the interests of factory-owners. In the Uttarkashi division, 7.35 lakh channels were tapped in 1961-62, extracting 1.59 kg per channel. By 1974-75, double the number of channels, 15.22 lakhs, were allowed yielding 3.55 kg per channel.

After several demonstrations in the late 1970s held at Nainital, Dehra Dun, Uttarkashi, Kotdwara and Tehri in front of the halls where forests were being auctioned, the State Government decided to conduct an enquiry. After the enquiry, the Government banned resin-tapping in some areas, but tapping by the forest department itself continued in other areas. Further protests by the local people — in the Henwal Gahti area of Tehri Garhwal, for instance — have led to a halt in resin-tapping in some other areas as well.

Pressure from tourists

The region of Uttarakhand, also known as Deva Bhumi (the land of the gods) faces every year a major influx of pilgrims and now increasingly tourists. This human pressure results in a heavy demand for fuel and, hence, pressure on forests. But the worse impact of this influx of tourists is felt in ecologically important areas like the Valley of Flowers which has been considered by ecologists important enough to be declared biosphere reserves. With its rapidly changing ecology, the number of flowers in this picturesque valley are going down every year. Before the latter half of this century, the valley was open only to the local shepherds. It remained protected because of a number of religious and cultural beliefs associated with it. Going into the valley wearing shoes, plucking flowers without prayers, plucking many flowers, making a noise in the valley, etc were strictly forbidden.

With the arrival of tourists and pilgrims in large numbers, the unique flora of the valley is seriously threatened. About 10,000 tourists are estimated to have visited the valley in 1978 and now the figure will be nearer 25,000. Though local graziers are now forbidden to enter the valley, there is no restriction on horses, either those belonging to the army or those carrying tourists. The introduction of horse dung has led to the growth of a new weed which is literally taking over the valley. An overzealous forest department has also totally denuded a large part of the valley to make a helipad for a proposed visit of Prime Minister Indira Gandhi which never materialised.

The beautiful pastures of Tungnath and Rudranath, on the other hand, continue to be under heavy pressure from the local cattle population. Several experts have pointed out that the cattle pressure is excessive in many parts of the region.

NORTHEAST HIMALAYAS

The northeast of India, linked to the subcontinent by a narrow corridor sandwiched between Nepal and Bangladesh, has one of the largest reserves of subtropical forests in India. Administratively divided into five states and two Union Territories, namely Assam, Meghalaya, Manipur, Nagaland, Tripura, Mizoram and Arunachal Pradesh, the Northeast can be regarded as one entity because of its common features.

The Northeast represents one seventh the total area under forest in India. It also plays host to a variety of birds and wild animals, including the famous one-horned rhinoceros, and to precious varieties of plant species. But the forest wealth of the Northeast is beginning to disappear before the eyes of the people who have lived in its midst for thousands of years.

Before the advent of roads, railway lines and so-called "economic development", the hills of the Northeast and the fertile plains along the banks of the Brahmaputra, were covered with lush subtropical forests bearing large quantities of evergreens and deciduous trees. The people in the hills — over 150 different tribes — lived in harmony with the forests around them and used a form of agriculture that allowed them to cultivate the steep slopes.

Today many tribes still follow this age-old method of cultivation called "jhum" (shifting cultivation) — an estimated 1.6 million are engaged in jhum — but there is disharmony. The forest areas are decreasing, human habitations are increasing, and the fertility of the soil is diminishing at such a rate that the land is turning barren.

Meghalaya

Meghalaya, "abode of the clouds", a state created out of three hill districts of Assam in January 1972, has seen the thick, tropical forests covering its terrain reduced to shrubs. So degraded is its forest cover, that today it is difficult to find a forest more than 50 years old.

The reasons for the denudation of Meghalaya's forest resources are at least partly linked to its complicated administrative structure. Under the Sixth Schedule of the Constitution, Meghalaya is divided into three district councils — Khasi, Garo and Jaintia Hills — which are elected legislative bodies with wide powers of governance, often duplicating those of the State authority.

Official statistics claim that 36.60 per cent of Meghalaya

The "Bamboo Famine" in Mizoram

Though there are about 16 species of bamboo in Mizoram in northeast India, the most abundant are the *Melocanna bambusoides* (called "Mautak" in the Mizo language) and the *Bambusa tulda* (called "Rawthing" in Mizo). The fact that there are relatively few trees and other forms of vegetation makes these species critical to the overall ecology.

The bamboo plant flowers cyclically; it flowers, drops its seeds and then dies out. New plants come up from the seeds and survive for a specific period and then the cycle is repeated: a true phoenix.

In Mizoram, the cyclic flowering of bamboos has a special significance. Whenever each of the two common varieties of bamboo flowers, there is an accompanying increase in the rat population which, in its turn, leads to a famine: Thingtam (caused by the flowering or Rawthing) of Mautam (caused by the flowering of Mautak). The rats attack the standing crops. This results in acute famines.

In Mizoram, the flowering in the bamboo belts, which run north to south, usually starts in one side-belt, then jumps across to the belt on the other side and finally affects the centre. Although the correlation between the flowering of the bamboo and the multiplying of rats has been observed, the exact causes are unclear. In fact, it is not only the rats which multiply but according to common belief even jungle fowl and other varieties of birds, along with certain types of insects, increase in number when the bamboo flowers.

The correlation between the flowering of bamboos and the increase in population of certain species is not unique to Mizoram. In Japan, for example, there was a reported outbreak of Smith's red-backed mole subsequent to the flowering of *Sasa ishizichiana* at Mt Tsurngi-Shikoku in 1954-55. However, nowhere does the outbreak reach the proportions that its does in Mizoram: this is perhaps due to certain peculiarities of the ecosystem in Mizoram.

Alongwith this phenomenal increase in the population of birds, insects and rats (local myth has it that even brinjals turn into rats), there is also an alleged increase in rainfall the year before the bamboo flowers. This was considered a folk belief associated with Thingtam and Mautam till 1976, the year before Thingtam, when there was appreciably heavier rainfall. Interestingly, research done by Taylor Green of the Pest Infestation Control Laboratory, UK, indicates that in East Africa heavy rainfall late in the season was followed, the next year, by an excessive rodent population. This was partly because the late rainfall helped weeds and grasses to grow and survive longer than usual thereby providing protection to the rodents from predators, mainly birds, and partly because these weeds and grasses also provided additional food to the rodents.

In 1977, subsequent to the flowering of bamboos in Mizoram the rats multiplied in thousands. They moved from village to village, from jhum plot to jhum, in groups of thousands. Often in a matter of hours whole acres of standing crop, mainly rice, would be destroyed. Though efforts were made at baiting and fumigation, traps were laid and pits dug around the jhums, the effect was marginal. The number of rats was so overwhelming that often pits would get filled in by the bodies of the front-line rats while those following behind would walk over these bodies and enter the fields.

No clear causal link between the flowering bamboos and the increase in rats has been established, though various theories exist. According to one theory as bamboo seeds contain a high concentration of protein (nearly 11 per cent), perhaps by eating them the cannibalistic urges of the male rat towards the young is deadened. Also, this high intake of protein might strengthen the rats thus lowering the rate of infant mortality. Of the species commonly found in Mizroam (*Rattus nitider* or the Himalayan rat and *Rattus Miviventer mentosu* being two of the main ones), the gestation period is said to be of 20 to 22 days. Considering one female rat can give a litter of 6-12 young ones and that the mother can attain almost immediate post-partum pregnancy, the rate of reproduction can be high.

Further, rats can breed throughout the year and the maturity period for a young one is about 60 to 70 days. If one combines all this, then one family of rats — producing an average litter of eight every month, and half its litter (the females) each again producing eight from their date of maturity — can produce thousands of rats in one year. Obviously, therefore, if reproduction was allowed to go on unchecked, and if there were no other balancing factors in the ecology, rats would soon rule the ecosystem. Perhaps the answer to the riddle lies not in any one factor but in a complicated combination of factors which, until discovered, will remain an enigma. In fact, until recently, most scientists discounted the tribal belief that famines follow the flowering of the bamboo forests.

It is perhaps not widely known that the roots of the Mizoram insurgency, and the outlawed Mizoram National Front (MNF), are to be found in the Mautam of 1959. Laldenga, the present leader of the MNF, formed in 1959-60 the Mizoram National Famine Front (MNFF) with the objective of fighting the famine. It was only later that the extra "F" was dropped and the organisation became the MNF with drastically different objectives. Whatever little sympathy the MNF got from the people has often been attributed to the neglect that the Mizos perceived, on the part of the central and State Governments (Mizoram was then the Lushai Hills District of Assam), while suffering from the famine in 1959.

— or 8528 sq km — is forest area. This is well below the 60 per cent forest cover laid down for hill areas by the National Forest Policy of 1952. The area under reserved forests, as claimed by the Meghalaya Forest Department, is 706 sq km, that is only four per cent of the total area of the State. In effect, this is the only protected forest cover in Meghalaya.

The remaining 7719 sq km or 90.51 per cent of the State's forests are unclassed state forests. They consist of forests directly managed by the District Councils, community-owned forests, village forests and forests owned by clans or individuals.

There is no data available on the extent of deforestation in these unclassed forests but it is apparent that it is extensive. The reason for this is the nexus between the desire for ready cash amongst the tribals and the accessibility to that provided by non-tribal contractors operating from outside the State. As private ownership is permitted under the Sixth Schedule, no State authority can check what tribal owners of forests do with their trees. Further, they are granted tax exemptions and other benefits not available to non-tribals. For instance, they pay only 50 per cent of the deposit required for bidding for a coupe of trees. They need show no financial securities for registration as contractors. In this way they become a front for non-tribal contractors who pay them a generous fee and operate that contract through them. For the tribals this is easy money with no risk; for the non-tribals it is easy timber fetching huge dividends. But for the forests of Meghalaya it has meant inevitable destruction.

For instance, the Garo hills, which only a few years ago had barely 15 to 16 officially licensed timber contractors operating within their forests, today have almost 800 licensed contractors. The bleak dead beauty of these hills, which were once covered with sal trees, are eloquent testimony to the pillaging of the forests.

Most of the timber from Meghalaya finds its way to Assam. It is impossible to check timber being smuggled out of the State because the long border between Assam and Meghalaya is unmanned in many places.

The Chipko Andolan

The Chipko Andolan—the movement to hug trees—is probably the world's most well-known grassroots ecodevelopment movement. Chipko activists have been subjects of newspaper articles and television programmes from India to the United States. They have attracted the attention of environmentalists, Gandhians and various people interested in the process of social change. Though pitted against the forest policies of the State of Uttar Pradesh, the movement has been praised by successive Prime Ministers. But despite its fame, the movement's objective of changing the State Government's forest policy and the current relationship of the hill people with forest resources, remains unfulfilled. Observers continue to be confused about what the movement actually stands for.

The Chipko movement was born one morning in March 1973 in the remote hill town of Gopeshwar in Chamoli District. On that fateful day representatives from a sports goods factory situated in Allahabad reached Gopeshwar to cut 10 ash trees near village Mandal. The villagers courteously told them not to do so but when the contractors persisted, they hit upon the idea of hugging the earmarked trees. The next day the sports goods manufacturers had to return empty-handed.

Some weeks later the same contractor surfaced at Rampur Phata, another village some 80 km away from Gopeshwar, with a fresh allotment from the forest department. As soon as the villagers of Gopeshwar learned of this, they marched to Rampur Phata with drums and songs, gathering more people on the way. A confrontation ensued and the agitators hugged the earmarked trees to foil the contractors once again.

The Chipko movement reached its climax in 1974 when the women of village Reni, some 65 km from Joshimath, got involved in a dramatic way. One day when their men were away in Joshimath protesting against the auction of a forest neighbouring Reni, the contractor arrived at the village to begin felling, taking this as an opportune moment. Undaunted by the number of men or their axes, the women of Reni, led by Gaura Devi, an illiterate woman of 50, barred the path to the forest which went through the village. As the woman stood there, they sang: "This forest is our mother's home, we will protect it with all our might."

The genesis of the Chipko movement has both an ecological and an economic background. The Alkananda Valley in which the movement originated was the scene of an unprecedented flood in 1970. The tragic aftermath of this flood left a deep impression on the hillfolk and, with it, soon followed the appreciation of the vital ecological role that forests play in their lives.

The villagers here have also seen and resent the manner in which successive governments—beginning with the British—have taken away their forest wealth and turned it into a resource bank for faraway urban markets. Even for minor forest produce and articles of daily necessity like firewood, the local people have been forced to become thieves in their own homeland. Slowly, the entire ecology of the region has changed. The local people prefer the broad-leaved oak. But with the demands of the industrial culture increasing, oak forests have been destroyed and replaced extensively by the chir pine. Today, when the local villagers want to get oak wood to make ploughs, they are allotted pine trees, whose wood is useless for this purpose.

When the Dasohli Gram Swarajya Mandal—the Gopeshwar-based organisation that has been at the forefront of the Chipko movement since its early days— decided to set up a small factory to use the pine resin, it was persistently discriminated against in the supply of the raw material. While the allotted quantity was small, the price was much higher than the prices at which the resin would be allotted to the larger factories down in the plains. No amount of persuasion or running to Lucknow seemed to work. The factory still limps along.

The non-violent, action-oriented Chipko movement has greatly helped to unite the people and focus attention on the mismanagement of forest resources. Its Gandhian character has brought it considerable sympathy. The expert committee set up by the State Government to enquire into whether the Reni forest should be felled found that the Reni women were more right from a scientific point of view than the forest department. This gave the movement considerable respectability. The committee concluded that because of the highly sensitive nature of the watersheds situated deep in the Himalayas, all felling should be banned to allow regeneration. These developments have not made the forest department change its forest policy but at least in the Chamoli district it is no longer in a position to implement its policy of selling forests to private contractors.

Meanwhile, as the years have gone by, the movement itself has acquired two distinct streams of thought marked by its two leaders, Chandi Prasad Bhatt from Gopeshwar who pioneered the movement, and Sundarlal Bahuguna from Silyara in the Tehri region. The operational style of both these leaders is totally different. While Bhatt is a grassroots worker and believes mainly in organising the people, Bahuguna, a journalist, is a publicist par excellence. Though Bahuguna has also organised some protest activities in his region—for instance, Chipko activists in Henwal Ghati once went to the forest to bandage the wounded trees with mud and sacking to protest against the indiscriminate tapping of pine trees—his main focus has been on spreading the message of Chipko far and wide. In 1981, Bahuguna started on a foot march from Kashmir to Kohima to campaign against deforestation.

Bhatt, on the other hand, has dug deep roots in the Chamoli region. He is, as a result, far less known than Bahuguna. Bhatt has realised that if the local village communities have the right to control their surrounding resources, they must also undertake to conserve and develop those resources. So he has organised the country's largest voluntary afforestation programme through ecodevelopment camps sponsored by the Dasohli Gram Swarajya Mandal. These bring together local villa-

ANUPAM MISHRA

gers, students and social workers who have planted over a million trees. The survival rate of these Chipko plantations has been an astonishing 85-90 per cent in most cases. Bahuguna, however, tends to dismiss this activity as irrelevant at this stage of the movement against deforestation and concentrates all his writing and speaking power against the forest departments.

The two leaders differ not just in their operational styles but also in their philosophy with respect to the use of forests. Bahuguna is fiercely ecological in approach. Regreening of forests is top priority—a matter of national defence—for him. For instance, he argues that the main objective of forest management in Himachal Pradesh should be soil and water conservation: forests do not bear timber, resin and foreign exchange but soil, water and pure air. The self-sufficiency of the hill people in food, clothing and shelter is important to Bahuguna but secondary to the major ecological objectives. He is suspicious of all types of forest-based industries, including those set up by the local people. He wants all commercial green felling to be stopped and no new contracts to be entered into with industrialists to supply raw material.

For Bhatt, however, the search for a new ecodevelopment process for the region and the involvement of the local people are primary issues. "Saving the trees is only the first step in the Chipko movement", says Bhatt. "Saving ourselves is the real goal. Our future is tied up with them". The economic conditions in the hills are today worse than even the average conditions of poverty in India. No conservation is possible without the cooperation of the people. Ecodevelopment strategies will inspire the poor when they are based not just on ecology but also on the needs of people.

Bhatt, therefore, wants forest resources to be used in a manner that is both environmentally and developmentally sound—in other words, while the environment is preserved, the benefits of the controlled exploitation accrue to the local people, a process in which decentralised economic growth and ecological conservation go hand in hand.

It is a fact that whereas tree felling has continued at the instance of the forest department in Tehri Garhwal, it is not possible to do so any longer in the Chamoli region because of the higher level of mobilisation of the local people there.

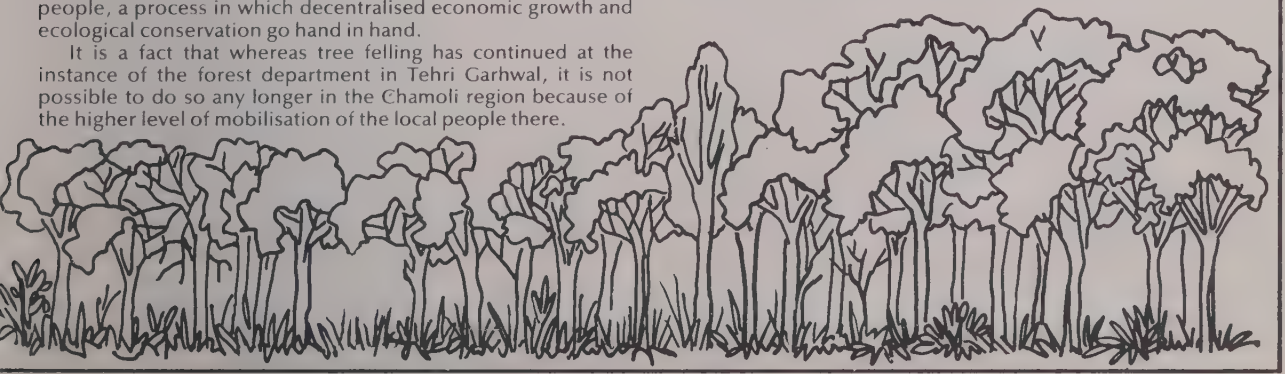
Notwithstanding the divergent opinions of these leaders, the real strength of the movement are the women of the region. Except for a few "organised" events as at Rampur Phata or Henwal Ghati, the Chipko movement essentially consists of a string of spontaneous confrontations in which none of the so-called leaders were present. Women, acting entirely on their own, rose up on the spur of the moment. While in Reni, this protest was against a timber contractor, in all other cases the protest was against their own cash-hungry men, who could not care less if the forest was destroyed while their women had to walk for many more miles to collect their daily load of fuel and fodder.

Two dramatic incidents have taken place in the Chamoli region: the first in 1978 in the Bhyundar Valley, the area that leads on to the famous Valley of Flowers, and the second in 1980 in the village Dungari-Paitoli situated in the Pindar watershed, which is so remote that the women there had not even heard of the Chipko movement.

In Bhyundar, the women were confronted by their own relatives from a neighbouring village who were going to cut trees to meet the fuel needs of the 250,000-odd pilgrims that visit the famous Badrinath Temple every year. As the men of the Bhyundar village had refused to cut the trees earlier, the forest department had stealthily given the contract to a cooperative society in a neighbouring village. The Bhyundar women stole the axes of the men and refused to return them until they agreed to go back.

In Dungari-Paitoli, the battle was much more bitter and set wife against husband and mother against son. In 1978, the Government's horticulture department negotiated with the male-dominated panchayat for the acquisition of a nearby community forest to set up a potato seed farm. The men were led to believe that they would get employment in the farm and with its construction, the village would get a motor road, electricity, health centre and its primary school would be upgraded to a high school. When the women learnt that the forest had been sold, they protested strongly. The destruction of the forest would have meant walking at least another five km everyday to fetch fuel and fodder. Emboldened by the support they received from the Chipko activists like Bhatt, the women refused to let the forest be destroyed. After a bitter struggle in which the women were strongly opposed by their men and threatened with arrests by the district administration, the women finally won. None of the men's tactics, including threats to Chipko workers and spreading of rumours that bowing to the women would mean the village youth would not get employment in the army, worked in the end.

At its heart, thus, the Chipko movement is very much a feminist movement. It has not only brought forth in a dramatic manner a greatly increased understanding of the divergent interests of local communities and State bureaucracies in the management of local resources, it is now finding that the interests of men and women within the same community can differ greatly. As long as the leadership of the Chipko movement remains sensitive to this learning process, the movement is bound to grow in strength. The latest demand to emerge from the women of Chamoli is that it is they who should be elected to the Forest Panchayats and not their men.



Land ownership

The pattern of landownership and the consequent diffusion of authority in Meghalaya makes supervision of forests, even by the District Councils, difficult. Land laws are not codified. The tribals have an oral tradition. People depend on customary laws handed down from generation to generation. So there is no record of land rights to indicate how much land is clan land, how much is community land or privately owned. Forests on such lands cannot be classified and therefore are open to unchecked exploitation.

There is only one plywood factory in Meghalaya, near the Assam border at Burnihat. But there are innumerable saw mills, some operating within the forest area. The investment in these saw mills is minimal, while the profit margin is maximised. The Khasi Hills District Council alone earns over Rs 40 lakhs per year from the export of timber. Unless they find alternative sources of revenue, district councils in the State are unlikely to take measures towards conservation.

The reserved forests in the State minute in comparison with those under private ownership or district councils, are supposedly managed according to a "working plan" and scientific tree felling. This system has proven flaws but its advantage is that is gives a vigilant and conscientious forester the powers to check the extent of damage visited on a forest. In the forests under the district councils there is no such plan of management, nor is there adequate supervision once timber contractors enter the forests. Their destruction, therefore, is all the more rapid and permanent.

The hilly terrain of Meghalaya, coupled with the presence of numerous swift flowing rivers and the stable geology, makes it ideal for the development of hydro-electric power. At present Meghalaya has an installed hydel capacity of 125.8 MW providing by far the largest amount of hydel power in the whole northeastern region. Tripura comes a poor second with only 10.0 MW of installed capacity.

Power in the State is generated from four projects: Umiam, stages one, two and three, and the Umtru project. Another project is under construction. According to the Meghalaya State Electricity Board, there were no studies done of the environmental impact of these projects.

Hydel projects require the construction of reservoirs for storing water. The area of the Umiam project, for instance, had excellent pine forests which had to be submerged.

The jhum cycle

Apart from the exploitation of forests by timber contractors, and development activities such as dams, road building etc, the system of jhumming or shifting cultivation has been a contributory factor in the denudation of the countryside.

The forests are victims of a vicious circle. Because there are more people and less land for cultivation — forest land that was once freely available has now been cleared for townships and other habitation — the jhumiya has reduced the cycle from 20 to 30 years to five to six years. Consequently the forest cannot be regenerated in the fields left fallow for such a short time. Agriculturists have found that while the 20 to 30 year cycle was being followed jhum was in fact the most suitable form of cultivation for these hill regions.

Each of the 150 tribal groups in the Northeast have socio-religious ceremonies linked with jhumming. Their social life is regulated by the jhum calendar. For instance, amongst the Mizos the Lue Kapha festival marks the search for a new field, and the Kang-Ral-Ni is the traditional day of mourning for creatures who die in a jhum fire.

At present, according to the jhumming pattern most commonly followed, farmers clear the forest, sometimes only the branches of the trees, in the first year. They let these dry in the sun, then burn the debris, and later plant a variety of crops. In the second year they plant paddy. They use the same plot at the most for three years, usually after two they move on. Before leaving they plant trees on this plot so that the forest can cover the land.

Reduced jhumming cycle does not allow the forest to grow, it also encourages harmful weeds to spread, weeds which would have died if the area had not been cultivated again. The slashing of the forest and the subsequent burning encourages the growth of certain weeds like *eupatorium* which has now become a real menace in the Northeast. It is largely responsible for reducing the nutrient value of the soil.

The reduced jhumming cycle, combined with the steepness of the slopes and the high rainfall in the region — averaging 2000 to 3000 mm because of its geographical location at the junction of the Burmese and Himalayan ranges where the rain-bearing monsoon winds converge — leads to severe soil erosion. Over time hillsides are laid bare.

The system of "bun" cultivation, where the tops of hills are used to grow potatoes on raised beds along the slopes, has resulted in an annual soil loss of 40 to 50 tonnes per hectare. For every tonne of potato grown in this way, two tonnes of soil are lost. Consequently these slopes become absolutely bare with no soil cover to the point that even grasses cannot grow.

Stark Cherrapunjee

The starkest example of the compounded effect of excessive jhumming in an area is seen in Cherrapunjee, reputedly the wettest spot on earth. With an average rainfall of 1150 cm, which comes down in torrents between the months of May and September, one would envisage this region as being covered with lush, subtropical vegetation. Instead, Cherrapunjee is a virtual desert; there is practically no topsoil on its barren hillsides. The people who lived off jhumming have been forced into other occupations. About 80 per cent of them have found employment in the local cement factory.

That Cherrapunjee was once part of a subtropical forest is proved by the existence of a few sacred groves, which have been protected from the lumberjack's axe because of the Khasi belief that it is inpropitious to fell the trees in these groves. The rich variety of vegetation in the Mawsymai sacred grove, near Cherrapunjee (or Sohra, as it is locally known), stands out as a vivid reminder of what the area was once like. Cherrapunjee's particular geographical location ensures a torrential rainfall; but the force of the rain, concentrated over a few months, combined with the cutting back of trees for jhumming, has played havoc with the top soil leading to the virtual desertification of the region.

It is clear that an alternative to jhum will have to be found, or other sources of employment for those dependent on the land, if the remaining forests in the area are to survive. Extensive studies have shown that the popular theory that intensive terraced cultivation is best suited to

these hill regions is not necessarily true. The capital-intensive inputs required in terms of fertiliser makes the green revolution type of agriculture out of reach for the small tribal farmer. Jhumming, on the other hand, ensures self-sufficiency for their immediate food needs. What they need to know now is how to cultivate the hillsides without eroding the soil to the point where nothing can grow.

Indigenous solutions

Some tribes have come up with their own indigenous solutions to the problem of soil erosion. For instance in Nagaland, the Angamis practise bench terracing even on steep slopes. They grow paddy on these fields and have a system of irrigation where water from higher terraces flows down into lower ones.

The Apatani tribals in the Subansiri district of Arunachal Pradesh have evolved a method of valley land cultivation. They have utilised an area of 2000 hectares of plateau, at a height of 1600 metres, for paddy cultivation without any modern irrigation system.

And in Muktapur, in the Jaintia hills of Meghalaya, the tribals have an ingenious bamboo drip irrigation system whereby they harness natural streams at the top of a slope to irrigate betel leaf and arecanut trees which they grow along the slopes. These local examples would be easier to popularise, and have a wisdom about them which modern methods do not.

Assam

The Northeast of India, and particularly Assam, supplies 60 per cent of India's plywood requirements. But the raw material needs of these factories, in thousands of cubic metres every day, cannot be regenerated at the speed with which they are consumed.

This unending demand for timber for industrial purposes is only one part of the multi-headed hydra which is consuming the forests of the lush northeastern State of Assam.

If one were to believe official statistics, 36.4 per cent of the total area of Assam is covered by forest; in reality, as even State forest officials readily admit, the percentage is closer to 19 per cent.

Besides an overcapitalised plywood industry, politically motivated schemes for settling people in forested areas have also contributed to deforestation.

Politics of encroachment

Between 1937 and 1946, the minority Muslim League provincial government in Assam, led by Saadullah, launched a "Grow more food" campaign. Under this pretext, thousands of Bengali Muslims from erstwhile East Pakistan were encouraged to settle in Assam. Reserved forests were under the Government's control; so hectares of forested land were cleared to make way for paddy cultivation. The object then was to make Assam a Muslim majority State so that it would be included in East Pakistan at the time of partition. The scheme did not work. But once the process of immigration had begun, it could not be checked. The current agitation in Assam against foreign nationals springs out of this situation.

The problem did not end with independence and partition. Any budding politician could see that if he got people legal rights to settle and cultivate land, he had a readymade vote bank. The forests of Assam became the cynosure of these politicians' eyes. They encouraged people to encroach into reserved forests, and when forest officials attempted to evict them, the people would move the courts and obtain a stay order. But the status quo ante could never be restored, whatever the ultimate outcome of the dispute, because the trees had already been cut. As one forest official commented bitterly, "Trees have no votes". In time the area would be dereserved and the encroachers were made legal settlers.

According to the forest department's figures, between 1961 and 1981, 11,241 hectares of reserved forest were dereserved and given over for human settlements. In addition, an estimated 1.36 lakh hectares of forest land are presently under encroachment.

Besides immigrants, forests have been used to relocate flood-affected people. But once a settlement is created inside a forest, it grows and eats into the forest area.

This is evident in the Panbari reserved forest, which is adjacent to the renowned home of the Indian one-horned rhinoceros, Kazhiranga. Here out of a total area of 1039 hectares, almost one fourth, or 253 hectares, were dereserved to settle 300 flood-affected families from Mazhuli, a river island on the Brahmaputra. The soil in Panbari is unfit for paddy cultivation, which these people were used to. All they can grow is mustard and some vegetables. Stealing firewood from the forest and selling it gives them an additional income. Life for them is hard, they are constant prey to wild animals as Panbari hosts the spillover from Kazhiranga, specially during the floods, as it is on higher ground. Every year a couple of villagers are killed. In despair, 25 families have left the area. The rest try and survive and are gradually encroaching further into the forest and cutting down the trees nearest their village.

Forest villages

The State politicians also used a provision of the Indian Forest Act (1927) to settle immigrants. Formulated during British times, this provision allowed for a limited number of forest villages to be located inside reserved forests to house the labourers needed for the maintenance of these forests. Each family was entitled to eight hectares of land to clear and cultivate, and also to keep five head of cattle. While the provision was selectively used, it created no problems.

After independence, however, forest villages began springing up at a rapid rate. Those living in them worked outside the forest but used provisions, such as tax exemption, to their advantage. The size of the original clearing would grow unchecked and eat into the forest. In just one division of Cachar district, Silchar, there are 116 forest villages today. The creation of more forest villages was stopped with the promulgation of the Forest Conservation Ordinance on October 6,1980 which was later converted into an Act. This law restrains State Governments from using any forest land for a "non-forest" purpose without prior approval of the Central Government.

The breakup of Assam into different states has also affected its forests as many of them lie along State boundaries and have now become areas of dispute. In the Behali reserved forest in Darrang district along the Arunachal Pradesh border, for instance, there is a 22 km strip which has not been surveyed. Before the State was divided, this

reserved forest spanned both States. The Assam side was flat land, the Arunachal side was hilly. The tribals in Arunachal, who had no flat land for cultivation, would use the land on the Assam side. Now they are considered encroachers and are accused of having taken over 74 sq km of the Behali reserve. The same story is repeated along the Assam-Nagaland border where clashes have resulted in several deaths. In these inter-state border disputes hectares of forest lands are also destroyed.

The Government claims that there are 17.21 lakh hectares of reserved forests in Assam. But this does not account for the area encroached upon. The unclassed state forests, which are often added to the total forest area — given as 30.71 lakh hectares — are mostly inhabited areas with few trees and comprise 42 per cent of the total forest area.

The plywood lobby

Upper Assam, and specially the district of Dibrugarh, has native trees like the Hollong, which are the best in the world for plywood. Hollong grows tall and straight for several score feet, all its branches are concentrated at the top and it is free of knots. Therefore it is ideal for peeling and pressing into plywood sheets.

With the improvement in communications, roads and the extension of the railway line, the possibilities of a plywood industry in the region proved feasible. The Assam Government offered such attractive incentives that plywood millers operating in West Bengal closed shop and moved to upper Assam. Today there are 52 plywood factories operating in the State and the industry contributes a significant portion of the revenue of State. In 1981, Assam's plywood mills exported decorative and commercial plywood and tea chest panels worth Rs 10 crores. In addition, they contributed to the Central and State exchequer, through central excise, sales tax, forest royalty etc, another Rs 20 crores.

The wood supplied to the plywood millers is highly subsidised. Timber priced at Rs 1485 per cu m in the market is supplied to them for Rs 500 per cu m for tea chests and Rs 740 per cu m for decorative plywood.

At present Assam's forests can meet only 22 per cent of the requirements of the State's plywood mills. The rest comes from Meghalaya, Arunchal Pradesh and Nagaland and much through illegal felling in these States.

Since the recent orders by the governments of Arunachal Pradesh and Nagaland, banning the movement of sawn timber outside their States, the plywood industry in Assam has been placed in some difficulty. The pressure on Assam and Meghalaya forests is bound to increase. Illegal felling poses few hurdles for the timber contractor as low-paid forest guards are easily bribed to turn the other way. The political influence of the plywood industry within the State ensures them of the Government's support in finding ways to meet their timber requirements — even at the cost of the forests.

Jhum cultivation in the two hill districts of Assam, North Cachar hills and Karbi Anglong, which have 40 per cent of the State's total forested area, is also contributing to deforestation. Oil and coal discoveries within reserved forests means further tracts of forests are cleared. Firewood requirements of people, which are not met in any organised fashion, leave the periphery of forests open to illegal felling for firewood.

Consequences

The most important consequence of deforestation in the Northeast has been the extent of siltation in its rivers. Through Assam flows the turbulent Brahmaputra which originates in Tibet, then makes its way along the Himalayas through Arunachal Pradesh to mark a winding and often changing course through 640 km of Assam. This impressive river, which in parts is 16 km wide, is fed by tributaries which come down from the region around Assam.

Deforestation in the catchment areas has turned these tributaries into gushing torrents which load the Brahmaputra with increasing quantities of silt each year. A case study done by the Brahmaputra Flood Control Commission of the Puthimari river, one of the major northern tributaries of the Brahmaputra, which originates in the sub-Himalayan ranges of Bhutan at a height of 4350 metres, showed an average rise in the river bed between 1968-75 of 0.5 m to 1.35 m per year.

Another indication of the rise in the river bed is obtained from the Dibrugarh division Embankment and Drainage Department. The danger level of the Brahmaputra at Dibrugarh is 119 metres. The high water mark for the last 40 years has shown a gradual rise and since 1960 it has always been above the danger mark.

Despite the clearly increasing damage caused by floods each year, there is little coordination or joint planning by the departments of flood control, soil conservation and forests. Each looks at its own problems. Furthermore, as the catchment areas lie outside the State, the State Government alone can do nothing without a joint plan being worked out with the neighbouring States of Arunachal Pradesh, Nagaland, Meghalaya and with Bhutan.

In Assam the root cause of much of the problem has been the unnaturally high increase in population over the last 30 years, the excess being due to migration from Bangladesh. According to the 1971 census figure, over 18 per cent of the population is working on the land. The growth of population between 1961-71 was 34.95 per cent as compared to the all-India average over this period of 24.80 per cent.

Unless people are given other sources of livelihood, they are bound to want at least a small plot of land. The pressure to occupy reserved forest lands, which are being used to supply timber to plywood factories, is only understandable in these circumstances.

THE CENTRAL FOREST BELT

After the Himalayan belt, the next largest concentration of forests is in Madhya Pradesh, Bihar and Orissa. These are mainly tropical moist deciduous and semi-evergreen forests.

These forests are also the home of the majority of the 44 million adivasis of India, who have drawn attention recently by launching movements on forest-based issues. Traditionally the existence of these tribals has been closely interlinked with the forest, and in this age of commercial forestry, it is their life that is most threatened by the ecological changes taking place.

Madhya Pradesh

Madhya Pradesh, for instance, earns more than any other State from its 15,389 thousand hectares of forests—Rs 139.44 lakhs per year. This represents 12.50 per cent of the total revenue of the State.

In an effort to increase the productivity of the forests, the State government accepted in 1976 a five-year $ 8.2 million World Bank funded pilot project to clear 20,000 hectares of natural forest land over a period of 20 years and plant pine plantations instead. This project would have yielded 50,000 tonnes of pulp a year, sufficient to meet the needs of a new Rs 250 crores paper mill.

The area cleared would have been a good portion of the 22,000 sq km forest area in Bastar district. Rich in sal (*Shorea robusta* to botanists), this area is largely inhabited by tribals. For them the sal tree is part of their daily life. It provides them with wood that is sturdier than teak; leaves which can be used for plates and bowls; and seeds, which can earn them money. Hindustan Lever now uses the sal seeds for making cocoa butter used in chocolate. Another local tree, the mahua, is also precious to the adivasis for its flowers. They can either be eaten raw, or cooked, or distilled for liquor.

The Jagdalpur-based Bastar Society for Conservation of Nature (Bascon) raised major ecological objections to the project. The society pointed out that pine plantations do not allow any undergrowth; furthermore, the fallen pine needles are a fire hazard.

The monoculture would have brought "development" to the area, but only at the cost of the adivasis. They could no longer subsist on forest produce once the natural forests were wiped out and replaced by commercial plantations. The only alternative left for them would have been to take to farming but the only available land is the forest land. This area is now "reserved" and, therefore, barred to the adivasis.

Previous efforts at growing monocultures of eucalyptus, an exotic species like pine, have proved unsuccessful in Madhya Pradesh. There were, thus, some doubts also about pine species imported from the Western hemisphere flourishing in the well-nourished soil of the sal forests. Pine is better suited to arid, degraded forest sites. In good, rich soil, the plantations would be susceptible to various diseases. Waheed Khan, a former Chief Conservator of Forests of Madhya Pradesh, argued that "clear felling high quality sal to raise plantations of tropical pines is neither scientifically desirable nor industrially necessary". Khan preferred plantations of mixed hardwoods. Moreover, bamboo can also be grown in the existing sal forests.

Although this particular project has been set aside, the drive to maximise profits from the forests has continued. Official records show that prior to 1958, trees worth Rs 15 crores were felled in the tehsils of Bastar while between 1958 and 1975 alone, trees worth Rs 35 crores were felled.

These official statistics do not give any idea of the extent of deforestation caused by illicit felling activities. According to one unofficial estimate, illegal felling in the State occurs to the extent of Rs 50 crores every year and honest forest officials are unable to control this pillage. Attacks on forest officials, rangers and guards by timber smugglers are now so common that the MP Forest Guard Association recently threatened to go on strike unless full protection was provided by the State Government. Trains full of illegally cut teak continue to roll out of the foest regions of Raisen and Hoshangabad. The forest departments of MP and Maharashtra have now started a joint monitoring scheme to prevent this illegal trade. The MP Government announced a ban on the export of firewood from the State from January 1, 1982; this ban has been challenged in court by the contractors.

Meanwhile, efforts to organise the Bastar tribals by locally influential persons like Baba Biharidas on the slogan of "Bastar timber for Bastar tribals" has created concern in the State Government, according to a recent report in the "Indian Express". In the mid-1970s, Baba Biharidas wielded influence over nearly half the tribal population of Bastar and ran an almost parallel government—he claims to be a reincarnation of Pravirchandra Bhanjdeo, the former ruler of Bastar. Today, although he is not so powerful, many Madhya Pradesh officials feel that by raising the forest issue he may succeed in mobilising the tribal populations. In January 1982, armed with their traditional bows and arrows, some 300 tribals forced forest officials to unload trucks carrying timber in the Mandapal forest. When a police party went to arrest the people involved, it was surrounded by armed tribals which led to a police firing. Three days later, 50 armed tribals surrrounded a police station and demanded the release of their arrested colleagues.

Bihar

In Bihar, however, the tribal groups are much more organised and have been demanding for long a separate State, Jharkhand. Forest-related issues have become a subject a major revolt against the State administration. Hundreds of tribals have been arrested over the last four years and at least 25 killed in what the "Hindustan Times" has called a "tree war". The main forest issue here is the replacement of the native sal trees by teak by the Bihar Forest Development Corporation, an activity which began in a big way in 1977 in the Singhbhum district of the Chotanagpur plateau.

Teak is a purely commercial timber, of no value to the tribals or their cattle. Elephants also miss the old sal forests and when they cannot find them tend to destroy the tribals' paddy fields.

In 1978, after nearly a year of petitioning the Government against teak plantations, the Singhbhum tribals began raiding tree nurseries, destroying saplings and forest buildings. In mid-1978, forest officials inspecting a teak nursery were locked up for 22 hours and had to be rescued by the police. As the tribal opposition grew, it met with stiff resistance from the State administration. Between November 1978 and January 1979, the police fired on demonstrators in Singhbhum on at least six occasions. As A.K. Roy, an MP from the area, puts it, for the tribals, sal has become a symbol of Jharkhand and saguwan (teak) a symbol of Bihar.

Since mid-1980, the tribal opposition has taken on another form, now popularly known as the Jungle Kato Movement. The tribals go to a pre-selected area in big numbers and cut hundreds of trees.

In September 1980 this resulted in what is now know as the Gua Massacre. Hundreds of tribals who had gathered at the iron mining township of Gua in Singhbhum to gherao the forest range officer, were fired upon by the police.

Three policemen and 13 tribals were killed, and over 200 were arrested.

The situation in Singhbhum continues to be tense. A "Times of India" report in February 1982 stated: "The Bihar Government's writ does not run in parts of the jungles under the jurisdiction of the Gua, Tonto and Chakradharpur police stations. Officials of the forest department here frankly admit that during the past one year even adivasi forest guards have not been able to enter the Songra range in Kolhan division, the Santara range in Porhat division and several other dense jungles virtually ruled by the tribals."

The report went on: "Without anybody to check them, the tribals are indulging in indiscriminate felling of trees. Almost every second day there are reports that trees have been felled over another 50 or 100 acres. The Singhbhum forest accounts for 30-40 per cent of the revenue of the State Government from the jungle. But for the past two years the working of the department has been completely paralysed here. Since the agitation began two years ago, the forest department has been sustaining a loss of over Rs two crores a year."

Tribal movements on forest-related issues are not new to the region. State control over forests has been a matter of tension ever since the British rulers arbitrarily declared forests as government property, classifying them as reserved and protected. The reservation of the forests resulted in the eviction of the tribals from the forest areas, thus, denying them their main source of livelihood.

The Chotanagpur region is extremely rich in minerals but the industrial development that has taken place has benefited mostly non-tribal populations from outside the region. Furthermore, these development activities have not only greatly eroded forest areas but have also destroyed the earlier lifestyle of the tribals dependent on the forests. Even basic amenities like water are now becoming difficult for the tribals. For instance, the few streams that pass through the thick forest of the Saranda division have been totally polluted by the washeries of the Indian Iron and Steel Company and the Bokaro steel complex. The tribal villages in the forest have thus been deprived of their only source of clean drinking water.

The tribals in Singhbhum today want not only their old forests back but also more land to eke out a livelihood, and from this springs both their love for the forest and their conflict with it. As one tribal told the "Times of India" reporter: "It may be wrong to fell trees. But what can we do? The Government has not provided us with any means of livelihood. The jungle is our ancestral property. We have to clear it for making land fit for cultivation." The current pattern of development, as far as the Bihar tribals are concerned, is such that it has snatched away their very environment from them, with which they coexisted for centuries, but has given them nothing in return.

Orissa

No tribal movements have been reported from Orissa but forest destruction continues at a rapid pace in this State too. Though Orissa is officially listed as one of the few remaining States where the forest area covers over one-third of the total land area, this is, in fact, not true. An analysis of satellite pictures taken from 1975 to 1977 has conclusively shown that well-stocked forests then covered only 2.83 million hectares—22 per cent of the total land area of the State—as compared to the total forest area of 5.54 million hectares. Further, as much as one-fifth of this area with a good forest cover is also affected by shifting cultivation.

Illegal felling and exploitation of forests for quick profits is a major problem in Orissa. A local reporter from Mayurbhanj district wrote graphically in "Sunday" magazine in early 1980 about a massive illegal forest cleaning operation in the Karanjia forest division that had taken place just then. A large number of permits had been issued by the State administration for felling trees to help local people meet their timber needs for house-building purposes and other such contingencies. But this wood, and much more felled illegally, entered the timber trade on such a massive scale that "nearly two trucks sped down the major district road every five minutes on a particular day", wrote the reporter.

A more recent report from the same district of Orissa describes a Government-sponsored project that seriously threatens to disturb the ecology of the unique forests situated in the picturesque Simlipal hills. The thick impregnable forests of Simlipal are rich in sal; they also act as a massive water reservoir for the three contiguous districts of Balasore, Mayurbhanj and Keonjhar. Several major rivers originate from the Simlipal hills. In their untouched state, these forests still have a variety of fauna, a few of which are also on the endangered list. The "Man and Biosphere" Committee of the Department of Science and Technology has suggested that Simlipal hills be conserved as a Biosphere Reserve.

Instead the State Forest Department is considering a Rs 12 crore project to exploit the forests' sal seeds. They are planning to send in thousands of workers to collect these seeds. The project is expected to double the Government's revenue from these forests from the current receipts of Rs two crores a year to Rs 4.23 crores in the very first year of the project. But the impact of human intrusion into the forest, and the clearing of its natural undergrowth, can be ecologically disastrous and has not been considered. Just the fuel needs of these large numbers of workers will lead to a massive destruction of trees.

Moreover, the collection of sal seeds through private contractors has led to heavy exploitation of tribals all over India. Firstly, contractors rarely hire local tribals who inhabit the forests but instead bring in work gangs from outside. Secondly, even if they do hire tribals, they pay them very little. Contractors in Madhya Pradesh, for instance, pay local tribals Rs 50 a quintal for sal seeds. They then pay the State Government a royalty of Rs 30 but finally sell the product at Rs 250 a quintal—a profit of over 200 per cent.

WESTERN AND EASTERN GHATS

The development of paper mills in Karnataka and Tamil Nadu is playing havoc with the bamboo forests of these States and increasingly with the bamboo resources of other States as local bamboo forests get depleted.

Bamboo today forms about 67 per cent of the raw material used by paper mills. For the current production of about 10 lakh tonnes of paper the total annual requirement of bamboo is about 19 lakh tonnes. Though the growth of the paper industry has slowed down, paper mills still continue

to expand. The annual average growth rate of the paper industry between 1951 and 1960 was 11.8 per cent, between 1961 and 1971 it was 9.1 per cent, and between 1971 and 1981 it was 5.1 per cent. But because of the shortage of raw material, paper mills are running at less than three-fourths of their capacity.

The area under bamboo in India is estimated to be about 10 million hectares according to the Central Forestry Commission. Bamboo brakes can be found throughout evergreen and semi-evergreen forests of south India. Sizeable areas of bamboo also occur in pure stands. There are two major species of bamboo available in large quantities in Tamil Nadu, for instance, *Dendrocalamus strictus* and *Bambusa arundinacea* (the thorny bamboo). Although the former grows better on well-drained hill slopes and comparatively dry places and the latter grows well on stream banks and comparatively wet places, often they can be seen growing together, the habitat of one merging into the other. Both these species attain their best growth in elevations between 490 and 980 metres and in areas receiving rainfall between 100 to 150 cm a year. In Tamil Nadu, bamboo is found on the slopes of the Eastern Ghats, starting from the Coimbatore North Plateau and extending till near Vellore. Good examples of moist bamboo brakes can be found in the Western ghats of Kanara in Karnataka, and Nilambur in Kerala.

Bamboos have been used by human beings since times immemorial. But it is only in the last four to five decades that industries have come to recognise their value. Forty years ago, the working plans of the then Mysore State, prescribed the eradication of bamboo as a weed of teak plantations. But once paper mills were installed in India, bamboo immediately became a valuable resource. Today it is so heavily exploited that large bamboo forests have already disappeared.

Karnataka

A study conducted by Madhav Gadgil and S. Narendra Prasad for the Karnataka State Council for Science and Technology (KSCST) concludes that bamboo stocks are declining every year in the State. A large number of areas in Coondapur division, Mangalore division, Sagar division, Chamarajnagar division and Koppa division — which were once rich in bamboo stocks — are now totally barren. Another study sponsored by the Bombay Natural History Society (BNHS) concludes that bamboo stocks are rapidly declining in various forest divisions of Tamil Nadu too.

Both the BNHS and the KSCST studies find the major cause of bamboo depletion is the overextraction by the paper mills. The KSCST report studied the demand and supply situations of three Karnataka mills: the Mysore Paper Mill (MPM) in Bhadravati; the West Coast Paper Mills (WCPM) at Dandeli; and, the Mandya National Paper Mill (MNPM) near Mysore. In each case the sustained yield calculations of bamboo stocks made by the millowners and the forest department have gone wrong.

MPM is not even getting half of what it had calculated would be the sustained yield of the surrounding bamboo forests; WCPM is getting just about a fourth; and, MNPM not even a fifth. WCPM is now forced to bring in bamboo from Kerala, Tamil Nadu, Maharashtra, Andhra Pradesh, and sometimes from as far away as Meghalaya.

The situation with Seshasayee Paper Mills at Erode in Tamil Nadu is exactly the same. It is facing extreme difficulty in meeting its needs of 50,000 tonnes of bamboo every year. A few years ago, vast tracts of bamboo flowered and died in the major bamboo division of the State — the Coimbatore North, Dharmapuri and Erode division. The Government is now hard pressed to supply the bamboo needed by the paper mill and hence pressure on other bamboo areas has increased tremendously.

With demand far outstripping supply, the pressure on extracting bamboo is becoming intense. Contractors supplying the paper do not follow the sylvicultural regulations meant to protect the regenerative capacity of the bamboo clumps. They concentrate extractions in easily accessible areas and overexploit the clumps there. They do not leave the current year's growth as required and often go to the length of clear felling whole areas. The BNHS study quotes the working plan of the Tirupattur division (Tamil Nadu) for 1964-65 to 1973-74, which frankly admits that "the so-called extraction is nothing but regular hacking of bamboo clumps. This damage has become serious since the beginning of the supply of bamboo to the paper mill at Erode".

The disappearance of bamboo stocks is having major environmental repercussions. Bamboo is a very good soil binder. The reduction in bamboo stocks inevitably means increased soil erosion. Ecologically, bamboo is a sun-loving species which can grow profusely wherever the canopy of moist or dry deciduous forest is opened up. With the disappearance of bamboo this ecological niche is being taken over rapidly by a weed called *Eupatorium glandulosum*, particularly in the moister tracts. Once this weed takes over, it smothers and totally suppresses all other regneration. It dries up in the dry season and promotes intense forest fires. Eupatorium is neither a good soil binder nor a soil builder like the bamboo. No animal touches it and its spread leads to a serious loss of even grazing lands.

Tamil Nadu

Thousands of poor villagers have suffered greatly because of this overexploitation of bamboo stocks by the paper mills. They depend on bamboo for food, house construction, manufacture of agricultural implements such as seed drills, and for making mats and baskets, an important source of livelihood. In Tamil Nadu alone, there are an estimated 23,000 people engaged in basket weaving, using bamboo as a means of survival. Probably a lakh of people would be dependent on these breadwinners.

Just about 10 years ago, the basket weavers of Kampanaickanpalayam, a village near the town of Sathyamangalam in Tamil Nadu, used to go into neighbouring forests, spend about half-a-day collecting bamboo and then come back and start weaving. The old and others who could not go themselves used to pay Rs 6 per headload of bamboo. An average family would earn about Rs 8 per day. There was also an uninterrupted supply of the right quantity and quality of bamboo.

Today, with the Seshasayee Paper Mill as a major competitor for the same resource, bamboo supply has become a major problem for the poor. Now some villagers specialise in collecting bamboo illegally and selling it to the weavers. These people have to travel nearly 25 miles to collect enough bamboo and it takes about three days. Each headload now costs anything above Rs 30; consequently, even with

Where has all the bamboo gone? Bamboo forests' stocks in south India are appropriated by paper mills, causing severe hardship to basket-weavers. (UNICEF/Mukul Dube)

prices of bamboo goods having risen, the weavers earn less than before. Moreover the bamboo supply is no longer assured. Whenever forest officials catch the bamboo collectors, the supply is cut off for weeks.

The BNHS study found that most of the bamboo available in the markets of towns like Madurai, Coimbatore, Salem and Erode now comes from far-off places in Kerala or the Tanjore region instead of the nearby bamboo forests which are either already depleted or used mainly by the paper mill. Local basket weavers have to depend on this expensive bamboo. Instead of responding to the difficulties of poor basket weavers, the forest department is favouring the paper mill. "For instance, in the Sathyamangalam area division," says the BNHS study, "for the past three years, all the bamboo coupes have been allotted to the mill."

This situation is obviously leading to much resentment. In fact, the study sponsored by the Karnataka State Council for Science and Technology on the dwindling bamboo resoures of the State was prompted mainly because of the agitation launched by the basket weavers of the State, say the authors of the study Gadgil and Prasad.

The destruction of forests across the Western and Eastern Ghats is a matter of major concern. Apart from illegal felling which remains a menace even in the southern States, several development projects like hydroelectric dams, the Kudremukh Iron Ore Project, roads, extension of farm lands are also seriously eroding the forest base of the region. The rivers which originate from these Ghats are fed by these forests, unlike the Himalayan rivers of the north which are perenially fed by glaciers. Therefore, a large part of the agriculture in these States is fully dependent on the forests in the Ghats and on the adjoining plateau.

In Karnataka, the mangrove forests along the west coast have almost disappeared. The scrub forest of the Deccan Plateau have been practically destroyed. The area under evergreen forests is being consistently reduced. The last representative of a climax evergreen forest in India — the Silent Valley of the Palghat division of Kerala — was recently threatened by a hydroelectric project. A major public campaign was able to save it.

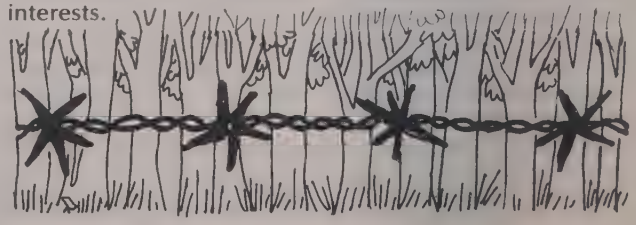
Kerala

Between 1940 and 1970, about 3500 sq km of forest lands in Kerala were diverted to non-forestry purposes, nearly two-thirds of which have been used as new farm lands. About 9400 sq km in the State are under forest cover at the moment. Large forest areas were assigned to the landless under the arable land scheme. In many cases rocky patches, totally unsuitable for cultivation, were found after the clearance of trees. In the absence of government assistance for land improvement, these lands have deteriorated rapidly and soil erosion has become a major problem.

Extensive forest areas have also been encroached upon around important projects like Idukki, Malampuzha and Reechi, leading to heavy siltation of the reservoirs. Landslides have also become common in many deforested parts of Kerala.

Large areas in Kerala are also being converted every year into plantations. By 1976, the total area under plantations was 1310 sq km or about 14 per cent of the total forest area. Three-fourths of this area was under teak and eucalyptus, an exotic species, even though changing ecology has led to the emergence of many pests and diseases. Eucalyptus plantations raised around Vazhachal have been almost completely wiped out because of a fungal disease. The system of taungya cultivation, growing tapioca amidst plantations, also appears to be unsuitable to the terrain of Kerala and is leading to severe soil erosion.

Tribal populations even in Kerala continue to suffer at the hands of non-tribal populations. In the hilly district of Wynad in north Kerala, forest encroachers, in collusion with forest officials, have acquired nearly 80 per cent of the land belonging to the local tribals. While only 20 per cent of the tribals in the district were classified as landless agricultural labourers 30 years ago, today they constitute about 80 per cent. Legal enactments to remedy this land alienation of tribals have met with powerful opposition from vested interests.



SOCIAL FORESTRY

There is today within the country, and in government agencies, a new consciousness about the importance of forests. Social forestry, that is, forestry aimed at meeting the fuel, fodder, fruit and timber needs of the people, is the current catchword.

Not only has the rate of afforestation picked up in recent years, interest in fuelwood plantations has also grown substantially. About 30 per cent of all plantations and 50 per cent of fuelwood plantations in the 30 years from 1951 to 1980 were planted in the last five years, from 1976 to 1980.

Recognising the intimate relationship between forestry and agriculture, the Government has increased allocation for plantations from Rs 1.28 crores in the First Five Year Plan (1951-56) with a social forestry component of Rs 16.42 lakhs, to Rs 452.20 crores during the Sixth Plan (1980-85), with a social forestry component of Rs 351.88 crores. The programme aims to cover a total of 2.15 million hectares, of which 1.52 will be under social forests and 0.62 under production forests. Thus, not only has the total afforestation effort increased but the social forestry component has increased in particular.

In addition to these Sixth Plan programmes, several State governments, particularly Tamil Nadu, Karnataka, Gujarat, Haryana and West Bengal, have already started or are formulating new social forestry projects with the financial assistance of international agencies like the World Bank, Swedish International Development Authority (SIDA), Canadian International Development Authority (CIDA) and the US Agency for International Development (USAID).

The Central Government has also sponsored programmes like a tree for every child, ecodevelopment camps involving college students in tree planting and free distribution of seedlings to farmers for farm forestry purposes. With all the programmes, the Government hopes to cover an area of three million hectares with fuelwood plantations during the Sixth Plan.

A Himachali woman with a load of fodder. In the Western Himalayan region, women walk upto 10 km a day to collect fuel and fodder. (UNICEF/Mukul Dube)

Tree revolution

A silent green revolution is reportedly sweeping through rural Gujarat, where social forestry programmes first began in the late 1970s. The achievements of Gujarat have attracted worldwide attention in the last four years. This year progressive Gujarat farmers are expected to plant 150 million trees over an area of 200,000 hectares. This is more than half of the acreage expected to be covered by plantation projects in the rest of the country by Sixth Plan schemes.

Under a Sixth Plan social forestry programme, rural fuelwood plantations will be raised in 100 identified districts where firewood is said to be particularly scarce.

Since the plan objectives were enunciated, the Fuelwood Study Committee of the Planning Commission has recommended drastically revised estimates. Emphasising the magnitude of the fuelwood crisis, the committee argues that 1.5 million hectares should be planted every year, together with a massive planting of trees along farm boundaries. This would mean distribution of 800 million seedlings every year at a cost of about Rs 800-1000 crores annually. The Government has not yet acted on the study committee's recommendations. The committee's advice that the Agricultural Prices Commission should include fuelwood in its charter and that the Government should provide a support price for firewood to encourage farmers to grow trees is likely to be accepted soon.

Social forestry critics

Despite these developments, many environmentalists are critical of government social forestry schemes. They question the choice of tree species, the wisdom of monoculture plantations and the nature of the actual beneficiaries of these schemes. State-sponsored farm forestry schemes in Gujarat and Karnataka have resulted in plantation of trees mainly of commercial value, notably eucalyptus. In Karnataka, for instance, the World Bank-funded extension of the existing social forestry programme plans to bring under tree cover some 110,000 hectares of private landholdings currently being used to grow crops. In Gujarat, a zealous forest department has been offering extension services to farmers willing to shift from agriculture to forestry. As a result, in Bhavnagar district alone, some 10,000 farmers have converted irrigated, prime agricultural lands into eucalyptus-growing lands.

Critics of these schemes like Sundarlal Bahuguna from

Table 5. Achievements of Indian forestry since 1951

PLAN/PERIOD	Social Forestry		Production Forestry		Total Plantation	
	Physical	Financial	Physical	Financial	Physical	Financial
First Plan 1951-56	15,130	1.642	36,957	11.191	52,087	12.833
Second Plan 1956-61	147,222	19.933	163,948	48.688	311,170	68.621
Third Plan 1961-66	260,315	54.305	323,054	156.964	583,369	211.269
Annual Plans 1966-69	127,806	42.890	325,171	187.346	452,977	230.236
Fourth Plan 1969-74	190,280	70.670	523,990	372.730	714,270	443.400
Fifth Plan 1974-79	567,335	525.326	653,861	547.480	1221,196	1072.806
Annual Plan 1979-80	121,877	219.541	101,301	135.459	223,178	355.000
Annual Plan 1980-81	152,811	337.242	95,325	161.259	248,136	498.501
TOTAL	**1582,776**	**1271.549**	**2223,607**	**1621.117**	**3806,383**	**2892.666**
TARGETS						
Annual Plan 1981-82	289,424	652.061	126,296	197.144	415,720	849.205
Sixth Plan 1980-85	1523,870	3518.835	624,042	1003.124	2147,912	4521.959

NOTES: 1. Figures for physical achievements are in hectares.
2. Figures for financial achievements are in millions of rupees.
3. Figures for 1980-81 are provisional.

Source: Report of the Fuelwood Study Committee, Planning Commission, 1982.

the Garhwal hills of UP charge that vested interests of paper millowners and synthetic fibre manufacturers are using a programme intended to ameliorate the poor man's energy famine. Certainly the National Commission on Agriculture had not envisioned a reverse conversion of valuable agricultural lands to forests when it had called for a halt to the destruction of forest lands for agriculture.

Eucalyptus is in great demand from the pulp and rayon industry. Mills in Karnataka are prepared to make advance payments every year to growers until the tree is ready for harvesting in 6-8 years. The prices offered are high: one acre of eucalyptus, when ready for felling, can fetch upto Rs 40,000. As a result, many farmers, particularly in Karnataka, have started growing eucalyptus instead of food crops.

Moreover, a research team from the Indian Institute of Management at Bangalore discovered in the Kolar district of Karnataka, that although the social forestry programme is expected to make a variety of tree species available to rural communities, the only seedlings that the forest department has been liberally distributing are those of eucalyptus, a tree which hardly fulfils the objectives of social forestry. Eucalyptus, as one critic puts it, is an "ecological terrorist": it provides neither fuel nor fodder, green mulch or shade. Instead, it tends to lower the water table. The local people prefer honge. Its wood is more suitable for burning and its seeds provide oil for medicinal and lighting purposes. But honge seedlings have never been distributed by the forest department.

The switch from growing food crops to eucalyptus is also criticised for promoting an unholy alliance between landowners and industry. The private farmer becomes less dependent on the community because tree growing needs less labour compared to growing food crops. Social forestry schemes can increase rural employment only when they are taken up in addition to agricultural programmes, not instead of them.

Displacing the poor

As in Karnataka, as much as 75 per cent of the plantation on village commons used for grazing will be under eucalyptus in Tamil Nadu's SIDA-supported social forestry scheme. Ironically, the introductory chapters of the project report piously note that one drawback of plantations on village commons is that they displace the poor who use the land for grazing. The scheme does not ask who will benefit from the cash returns that the eucalyptus trees will bring after eight years. The village panchayat is unlikely to distribute this revenue equitably or use it for the benefit of the entire village. The project report itself notes that involving the village panchayat in administering the programme means, in effect, coopting the rural elite.

Tree species are seldom mentioned in State governments' plans for social forestry. Without knowing the exact species, the extent to which the common man will benefit

cannot be calculated.

In the Garhwal hills of Uttar Pradesh, recent afforestation efforts have replaced naturally growing, broad-leafed deciduous species such as oak, ash, pangar and saud with trees like deodar and mulberry which have industrial and commercial value. While the old stands of broad-leaf trees produced a rich humus and held the rain water well, the new trees do not play an adequate ecological role. The survival rate of the new varieties is also poor. In 1974-75, of the 606 deodars planted in the Mandal-Dhotidar area only 158 survived. Out of 2060 mulberry saplings planted, only 60 survived. In contrast, out of 6250 ash saplings planted in 1977-78, 6050 survived. These afforestation efforts fail because local people do not care for commercial value species as they stand to gain nothing from them. In due course, the walls protecting the saplings break down and grazing cattle destroy the saplings.

The efforts to introduce a pine monoculture in the garb of social forestry has been strongly opposed in the Bastar district of Madhya Pradesh. In Bihar, enraged tribals have uprooted the teak monocultures planted by the State forest department in place of sal.

Stifled by bureaucracy

Furthermore, most social forestry schemes are being implemented by highly centralised slow moving bureaucracies, making them prone to failure. Project Aranyavali, covering 213 panchayats of Ratlam district in Madhya Pradesh, is a good example. Designed by an enterprising IAS officer, the scheme intended to cover several hectares in every village. Schoolchildren from each village planted a tree and on each sapling the name of the child planter was attached. The child was expected to take responsibility for the care of the tree and, in the long run, would also reap its benefits. Unfortunately, the distance between the schools and the tree planting sites turned out to be too far for the children to make frequent trips. The responsibility ultimately fell on the forest department, which took six months to activate itself, to take care of the trees. During this time 50 per cent of the saplings died. Then came a controversy over funds and in the process another 35 per cent of the saplings died.

These developments raise several questions about the extent of participation in current social forestry programmes. Of the three major components of social forestry schemes—creation of community woodlots on village lands, farm forestry and strip plantations—the first two definitely require community participation. Saplings do not survive unless villagers cooperate.

Community participation can be sought in two ways: by educating and motivating the local people involved or by

Preparing an ecological and agricultural disaster? In Bhavnagar district in Gujarat, about 10,000 farmers have converted prime agricultural land into profitable eucalyptus farms. (Kanan Mehta)

offering them material incentives. Voluntary agencies (who, significantly, prefer to use the term community forestry in place of social forestry) usually opt for the former and government agencies for the latter.

Gujarat's example

The Gujarat Government has been innovative in finding ways to get villagers to donate their labour voluntarily for afforestation programmes. It provides smokeless chulhas, which cost Rs 67, free to families that donate their labour. These chulhas reduce fuel consumption by upto 50 per cent and also emit less smoke. The forest department also builds brick-lined crematoria in villages which donate labour for forestry programmes. These crematoria require only half the amount of wood needed by open pyres and meet a felt need. With the scarcity of wood, rural poor, particularly the harijans, are finding it increasingly difficult to cremate their dead. Both these programmes have succeeded in eliciting popular participation in social forestry.

The Gujarat Government has also invited villages located in or near degraded forests to regenerate degraded forests themselves by planting fruit, fodder and fuelwood trees. Usually foresters tend to protect forest lands from the local people. Gujarat has also involved schoolchildren in afforestation through a scheme introduced in the International Children's Year. Saplings are provided free to schoolchildren who plant and nurture them, usually in the school compound.

The Tamil Nadu project has devised an incentive programme whereby households will be given a free supply of 500 seedlings each of fuel, small timber, fodder and fruit species. At the end of each year, cash incentives will be paid for surviving plants. The project hopes to cover 100,000 families in five years, at a cost of Rs 1.43 crores. The Tamil Nadu project also plans to create a cadre of locally recruited workers, including women, who will motivate and train people to run social forestry schemes.

The Forest Bill

Few documents reveal more clearly the official attitude towards forests than the proposed new Forest Bill which is slated to replace the existing Indian Forest Act of 1927.

Prepared in 1978 by the Central Board of Forestry following recommendations of the National Commission on Agriculture, the Bill has not yet been introduced in Parliament. Officials, including the Inspector General of Forests, deny that it is anywhere near its final stage. Copies of the draft Bill have been circulating amongst voluntary organisations and activist groups who have analysed it and pointed out to the Government the adverse fallout it would have on the life of the country's adivasis if implemented.

The first legislation concerning forests dates back to 1865. The Government Forest Act of that year gave the Government the right to declare any area as a reserved forest. But there were some restrictions in it, especially that the Government could not abridge the existing "rights of communities" living in or near forests. This legislation followed the British recognition of the economic importance of forests when they felt the need for railway sleepers for the newly-laid railway lines and timber for underground structures in coal mines.

Two decades later, in 1878, the Indian Forest Act was promulgated and for the first time forests were divided into three categories: reserved forests, which were virtually government forests where it could settle, transfer or commute the rights of communities; protected forests, where the rights of communities were recorded and regulated but the Government could not commute them; and, village forests where there were no government controls over the rights of people.

The Government could take over forests from tribals and declare them reserved forests. Forest officers had magisterial powers and could arrest people without a warrant if reasonable suspicion existed of their having committed an offence inside the reserved forests.

After four amendments, the Act became the Indian Forest Act 1927 which is still in operation. This gave the Government the right to charge levy on timber and forest produce in government and other forests. The list of offences increased with the Act and maximum punishment was six months imprisonment or Rs 500 fine. The Act also modified the phrase "rights of communities" to "rights and privileges of persons", thus further reducing the access of forest-dwellers to the forest.

After independence, the Government felt the need to articulate a forest policy which it did in 1952. But the National Forest Policy was only a modified version of the policy statement on forests made by the British in 1894. Among the six permanent objectives outlined in the policy was the necessity to generate maximum annual revenue from the forests; this slowly became the dominant theme. This emphasis on revenue also accentuated the alienation of forest dwellers from their land. By blocking off areas of forests from adivasis without giving them any alternative livelihood, the Government left them with just two options: either to illegally and forcibly occupy forest land and cultivate it, or to become forest labourers earning a pittance from cutting the very trees that provided them with their basic essentials.

Organised forcible cultivation of forest lands by tribal groups has unwittingly made them the scapegoats in the Government's ploy to increase bureaucratic control of forests. Accusing them of destroying forests, the Government states as two of the objectives of the proposed Bill the prevention of the use of forest land for agricultural purposes and regulating the customary rights of people. (The traditional burial grounds of adivasis are also often in the middle of reserved forests). Other objectives of the proposed legislation include the prevention of large-scale deforestation, stopping private contractors in the forests and maximising revenue.

In the draft legislation the list of offences has increased and includes "gathering forest produce" which it defines in detail; in the list of 36 forest products are included grass, flowers, leaves, branches, things that adivasis collect at present without restrictions.

Included in the Bill's 15 chapters and 143 sections are powers by which "any land whatsoever ..... which the State government declares to be a forest", becomes a reserved forest. Furthermore, forest settlement officers, who deal with disputed areas in reserved forests, will have powers of a civil court to settle any claim on reserved forest area. These disputes usually involve adivasis.

Forest officers will also have powers to arrest without warrant and punishment for committing any of the many listed offences, including gathering forest produce, can be three years imprisonment, fine up to Rs 5000 or both. Punishment could be doubled if the crime is committed "after sunset or before sunrise".

These and other provisions of the proposed Forest Bill have to be seen against the background of the effect they will have on the adivasis. If caught in the act of collecting firewood, flowers or fruit, all actions which have been an integral part of their existence, the adivasis will face the strong punishment prescribed in the Bill. Meanwhile the real plunderers of the forests, the private contractors working for the timber-based industries, will continue to find few obstacles in their way. Even if private contractors are stopped from entering reserved forests, the experience of States where government-run Forest Development Corporations have been formed, is that the very same contractors find their way in, this time working for a nationalised corporation.

Table 6. Area of established plantations 1951-1980 (thousand hectares)

Type	1951-60	1961-65	1966-70	1971-75	1976-80	TOTAL
Industrial	190	321	534	545	607	2197
Fuelwood	3	40	68	84	191	386
Environmental	65	152	142	119	121	599
Total	258	513	744	748	919	3182

NOTE: The average survival rate of industrial plantations is estimated at 70 per cent, that of fuelwood plantations at 60 per cent, and of environmental plantations at 50 per cent.

Source: Forest Resources of Tropical Asia, FAO, 1981

Voluntary efforts

Voluntary agencies, on the contrary, do not try to buy the beneficiaries with hard cash. The Dashauli Gram Swarajya Sangh in the Chamoli district of Uttar Pradesh, which spearheaded the Chipko Movement in 1973, has had notable success in involving village communities in afforestation programmes. Afforestation camps — or ecodevelopment camps as they are known — are organised periodically in the region. Students and volunteers, join the local people in planting saplings, making bunds and erecting breastwalls. Local people, especially the women, nurture the saplings all year round, the survival rate often being as much as 90 per cent. Trees planted are varieties that both men and women consider useful.

In Ranchi, the Xavier Institute of Social Service has mediated between the local residents and the forest department so that trees can be planted by the latter on private landholdings. The department first had to agree to withdraw petty cases of theft registered by forest guards against local people who collect firewood from reserve forests. In Jamkhed, Maharashtra, the Comprehensive Rural Health Project has converted seven acres of its 40-acre farm into demonstration plots for subabul and sisal. They have distributed 100,000 subabul saplings among the surrounding villages. They also combine tree planting with nutrition. Girls of 8-12 years, who come to balwadis, are given six-month old saplings of papaya and drumstick to plant and care for at home. As a part of the community outreach effort at the Agricultural Institute at Kosbad Hill in Thane district, mothers of children who attend the anganwadis are given demonstrations on tree culture, and then distributed plantation kits and saplings so that they can grow fruit and foddertrees on their homesteads.

Community forestry efforts of voluntary agencies are much smaller in scope than State-sponsored efforts but are usually designed to meet essential needs and generally evoke better popular participation.

UNICEF/MUKUL DUBE

DAMS

- *Despite an investment of Rs 7510 crores on major and medium irrigation works, the average national yield for irrigated lands is only 1.7 tonnes of grain per hectare as against the target of four to five tonnes per hectare.*

- *In Jammu province, which derives 89 per cent of its power from hydroelectricity, transmission losses amounted to 62 per cent in one year.*

- *Siltation rates of the reservoirs of major dams are three to four times higher than the project rates. The life-time of the Tehri dam may be just 30 to 40 years instead of the proposed 100 years.*

- *The Silent Valley hydroelectric project in Kerala poses the threat of extinction to biological species that have evolved over millions of years.*

- *Ill-planned construction schedules at the Kali river hydel project in Karnataka have led to severe soil erosion and loss of topsoil in the catchment area, making it a desert unfit for cultivation for all times.*

- *Benefit-cost ratios for dams are inflated to win the approval of the Planning Commission. Independent assessments reveal that for many projects the ratios are significantly less than one.*

- *Small hydroelectric projects have been ignored by Indian planners, despite the tremendous potential of such schemes. By contrast, in China, 87,000 small hydropower works generate a third of its hydroelectricity.*

4

DAMS

In this century, India ranks among the more important dam building nations in the world. Soon after independence, multi-purpose river valley projects and other dams came to be regarded as essential for meeting the country's critical requirements of irrigation for agriculture, electricity for industries, and flood control. Dam building has been pursued at an accelerating pace in the last three decades.

"Irrigation and hydro-power have been the major objectives of water resources development in India," says C.V.J. Verma, Secretary, Central Board of Irrigation and Power (CBIP). By 1979, the Government of India had invested Rs 10,556 crores, nearly 14 per cent of the total planned expenditure, on dams and canals of various sizes. The "Register of Large Dams" published by the CBIP defines 1554 dams as large. Of these 113 were under construction in 1979. Over a third of all these dams are in the State of Maharashtra (Table 1). The 10 largest Indian dams include some of the biggest in the world (Table 2).

Most of the construction work on dams in India is done by human labour. These dams are, therefore, standing testimonials to human toil and engineering skills. Little wonder then, that Jawaharlal Nehru was moved to describe them as the "temples of modern India".

In 25 years, from 1954 to 1979, the installed hydroelectric energy generating capacity rose 12 times, from 3.24 billion kilowatt-hours (kwh) to 39.4 billion kwh. The irrigation potential created by major and medium size projects increased from 9.7 million hectares in 1950-51 to 26.6 million hectares in 1979-80. Irrigation is the single most important factor in our achieving a fair measure of self-sufficiency in food production.

Despite these impressive achievements, the expected benefits, in terms of the actual generation of electricity, irrigation and flood control, have fallen short of the planned targets. If the costs of environmental degradation, such as deforestation in the catchment areas, are included, the price paid for these modern temples becomes truly staggering.

Table 1. Large dams in India

In 1979 there were 1,554 large dams, some still under construction, in the various States and Union Territories of the country

ANDHRA PRADESH	74
BIHAR	31
GUJARAT	276
HIMACHAL PRADESH	3
JAMMUAND KASHMIR	7
KARNATAKA	63
KERALA	44
MADHYA PRADESH	131
MAHARASHTRA	631
MEGHALAYA	6
ORISSA	39
PUNJAB	2
RAJASTHAN	67
TAMIL NADU	77
UTTAR PRADESH	84
WEST BENGAL	17
GOA, DAMAN AND DIU	2

Source: Register of large dams in India, CBIP, New Delhi, 1979.

Table 2. India's highest dams — basic information

NAME OF DAM	RIVER/STATE	GROSS CAPACITY OF RESERVOIR (million cu m)	HEIGHT/ LENGTH (m)	PURPOSE (a)
Tehri (b)	Bhagirathi/UP	3539	261/570	I H
Kishau (b)	Tons/UP	2400	253/360	I H
Bhakra	Satluj/HP	9621	226/518	I H
Lakhwar (c)	Yamuna/UP	580	192/440	I H
Idukki	Periyar/Kerala	1996	169/366	H C
Srisailam (b)	Krishna/AP	8722	143/512	H
Cheruthoni	Cheruthoni/ Kerala	1996	138/650	H C
Sardar Sarovar	Narmada/Gujarat	9492	137/1210	I H C
Pong	Beas/HP	8570	133/1950	I H
Silent Valley (b)	Kunthipuzha/ Kerala	317	131/430	H

NOTES: (a) I: irrigation; H: hydroelectric power; C: flood control
(b) Under construction
(c) Seventh Plan

Source: Register of large dams in India, Central Board of Irrigation and Power, New Delhi.

REVIEW OF BENEFITS

Irrigation

The National Commission on Agriculture has estimated that about 40 per cent, or 70 million hectare-metres, of the average annual surface flow in India's river basins can be utilised for productive and domestic purposes. The actual amount used is about 25 million hectare-metres.

Between 1951 and 1980, the Indian Government spent Rs 7510 crores on major and medium irrigation works. This resulted in an additional irrigation potential of 17 million hectares, according to the Sixth Plan document (Table 3). The actual area irrigated, however, is much less due

Table 3. Outlay on development of irrigation potential

	Outlay/expenditure (million rupees)		Cumulative irrigation potential (mha)	
	Major & medium irrgn	Minor irrgn	Major & medium irrgn	Minor irrgn
Pre-Plan benefits	—	—	9.70	12.90
First Plan	3800*	760	12.20	14.06
Second Plan	3800	1420	14.30	14.79
Third Plan	5810	3280	16.60	17.01
Annual Plan 1966-69	4340	3260	18.10	19.00
Fourth Plan 1969-74	12370 (a)	5130	20.70	23.50
Fifth Plan 1974-78	24420 (b)	6310	24.82	27.30
Annual Plan 1978-79	9770	2370	25.86	28.60
Annual Plan 1979-80	10790	2600	26.60	30.00
	75100	**25130**		

NOTES: *Inclusive of Rs 800 million incurred during the pre-Plan period.
(a) Excludes Plan outlay an unapproved Kaveri basin projects.
(b) Excludes non-Plan outlay on unapproved Kaveri basin projects.
—— figures for minor irrigation pertain to governmental outlays only.

Source: Sixth Five Year Plan (1980-85), Planning Commission, Government of India.

to delays in constructing field channels and water routes.

The Planning Commission has admitted, in the Sixth Plan document, that the huge investments made in irrigation have yielded disappointingly low returns in terms of yield as well as finance. While irrigated land should annually yield at least four to five tonnes of grain per hectare, the national average for such fields is only about 1.7 tonnes per hectare.

Many states are unable to recover even working expenses from their irrigation projects. The annual losses amount to Rs 427 crores, according to the Sixth Plan document. The reasons for this situation are many. The most important is the delay in completion of schemes. Major dams like the Nagarjunasagar project (Andhra Pradesh), Gandak and Kosi projects (Bihar), Mallaprabha (Karnataka), Tawa (Madhya Pradesh), and Kangsabati (West Bengal), to name a few, have been under construction for 15 to 20 years.

The development of irrigation in the different states has been lopsided. Punjab, Tamil Nadu, Haryana, Rajasthan and Uttar Pradesh have the highest percentage of cultivated land under irrigation. On the other hand, in spite of having the maximum number of dams in the country, only 41 per cent of Maharashtra's cultivated area is irrigated.

Use of surface water for irrigation has proved to be costly. The Planning Commission's figures show that an average investment of over Rs 2800 was required to create one hectare of irrigation potential by major and medium irrigation schemes. On the other hand, ground water irrigation systems, the corresponding figure is only about Rs 840.

Hydroelectric power

Though the installed capacity for generating hydroelectric energy had increased to over 41 million kwh in 1980, it represented merely 10 per cent of the nation's potential as assessed by the Central Electricity Authority in 1978. Its contribution to the total energy consumed in India is small (Table 4).

Besides being a renewable and non-polluting source of energy, hydropower is supposed to be cheaper than thermal or nuclear power. Persistent delays in commissioning hydroelectric projects, however, have escalated generating costs to an average of Rs 7000 per kw, according to the Working Group on Energy Policy of the Planning Commission sion. This compares unfavourably with the corresponding figures for nuclear and termal energy—Rs 7000 and Rs 4000 per kw respectively. The gestation period for these plants is five to 12 years compared to five years for thermal power stations.

The benefits of the massive investment in hydroelectric projects have gone mainly to the urban areas. This is because the industrial sector is the largest user of electrical energy in India. The corresponding share of agriculture, though rising steadily since 1954, stood at a meagre 14.2 per cent in 1978-79. During periods of peak demand or low power production, for example in summer, electric supply to rural areas is frequently bypassed in favour of some urban areas. Many farmers keep a diesel pump as a back-up.

The most notorious borrower of electricity is the capital, New Delhi. Due to archaic planning, the northwest districts of the city obtain their power from the Bhakra-Beas hydel grid rather than the thermal power plants in New Delhi. The city persistently drew more than twice its allotted share of 150 MW last summer, to the detriment of farmers in Punjab, Haryana and Himachal Pradesh. The irony is that the instal-

Table 4. The share of hydroelectricity in India's energy consumption

YEAR	Total energy (all forms) consumed 10^9 kwh	Total commercial energy consumed 10^9 kwh	Total electrical energy consumed 10^9 kwh	Total hydel energy generated 10^9 kwh	Hydel as fraction of total energy consumed (per cent)	Hydel as fraction of commercial energy (per cent)	Hydel as fraction of electrical energy (per cent)
1953-54	186.3	60.4	7.6	3.24	1.74	5.36	42.63
1960-61	246.7	101.2	16.9	7.84*	3.18	7.75	46.39
1965-66	306.6	147.0	30.6	15.32*	5.00	10.42	50.07
1970-71	369.5	197.3	48.7	22.03*	5.96	11.17	45.24
1975-76	447.5	252.7	66.0	27.75*	6.20	10.98	41.67
1978-79	—	294.3	84.4	39.40	—	12.16	46.68

Sources:
(a) Columns 1, 2 and 3 from the Report of the Working Group on Energy Policy, Planning Commission, New Delhi, 1979.
(b) In Column 4, figures without asterisks are from the above report. Figures with asterisks are approximate and are based on data from the Central Electricity Authority, New Delhi; they have been obtained by proportionately scaling down the CEA's estimates to match the data of the Working Group. (The CEA's figures for total electricity consumed and for the hydroelectricity generated are higher than the Working Group's estimates.)

Hydropower: the energy contained in water falling over a dam is converted to electrical energy. Water bursts forth from the Srisailam dam, India's sixth highest. (India Today/Pramod Pushkarna)

led capacity of Delhi's power plants is almost twice the city's requirement.

Everything is not well at the industrial front either. Reviewing the power situation in the country, the Sixth Plan document states, "Substantial as the growth of the power sector has been, power shortages have become almost endemic in various parts of the country. The rate of growth of power generation has not matched the growth of the installed capacity, much less the growth of demand for electricity..... In the five year period 1974-79, the shortfall in the addition of new generating capacity compared with the target was as high as 40 per cent."

Transmission and distribution losses due to inadequate investment and implementation, further reduce the benefits available from the installed capacity. The national average of 20 per cent is almost double that of most of the developed nations. In Jammu province, which derives 89 per cent of its power from hydel sources, transmission losses amounted to 62 per cent at the start of the current plan, according to a report of the Comptroller and Auditor-General of India. As a result, losses to State Governments have risen from Rs 1400 crores in 1979-80 to almost Rs 2000 crores this year. Rampant corruption has led to a scandalous pilferage of power. In Kashmir, 52 per cent of the total power generated, was pirated away last year.

There are serious regional imbalances in the distribution of the hydroelectric power generated. Often the least to benefit are the people of the regions where the dams are located. In Himachal Pradesh, 85 per cent of whose hydel potential has been tapped already, the per capita annual consumption of electricity is only 56.6 kwh, less than half the national average of 130.5 kwh. In Punjab, the main beneficiary of Himachal's dams, the per capita consumption of 314 kwh is the highest in the nation.

Analysing the benefits of the river valley dams in North Karara district of Karnataka, Vijay Paranjpye, a development economist, writes, "The Government intends to feed the entire power thus generated into the regional grid at Hubli and then distribute it through the central pool. In essence this implies that the entire power will be used by the urban and industrialised sector because the government has presently no plans for electrifying the rural areas near the dam site."

Flood control

Dams, by impounding a river's water which is released at a controlled rate, act as a buffer against floods. Few dams are designed specifically for flood control. Thus in the "Register of Large Dams" only 17 out of the total list of 1554 are identified as flood-control projects. They are all, of course, multi-purpose projects. These include the Panchet Hill dam over the Damodar river, the Sardar Sarovar which is under construction across the Narmada, the Idduki over the Periyar and Hirakud dam across the Mahanadi.

The National Flood Control Programme launched in 1954 has constructed embankments, drainage channels and town and village protection schemes. By 1979, Rs 975 crores had been spent on these schemes. In gross terms, the flood control programme has been a failure since the area affected and the economic damage increased sharply and consistently in the last three decades (Table 5).

Heavy siltation has substantially reduced the storage capacity and the lifespan of many reservoirs, including those of important multipurpose projects. Siltation data (Table 6) shows that the rates forecast were three to four times lower than those actually observed. As a result, reservoirs are incapable of absorbing heavy floods and have to resort to panic discharges, leading to destructive flash floods in the valleys downstream. The disastrous floods in

Table 5. Damage caused by floods, 1953 to 1981

Year	Cropped area affected (lakh hectares)	Total damage (million rupees)	
		At current prices	At 1952-53 prices
1953	9.3	540	520
1954	26.5	580	590
1955	54.0	1190	1340
1956	21.0	510	510
1957	4.5	240	220
1958	14.9	510	460
1959	15.4	790	680
1960	26.5	670	550
1961	18.3	320	260
1962	35.6	930	750
1963	19.7	380	300
1964	24.7	670	450
1965	2.5	60	30
1966	16.1	650	340
1967	33.0	1370	620
1968	26.9	2030	950
1969	43.4	3330	1490
1970	48.5	2870	1210
1971	62.4	6320	2630
1972	24.4	1580	630
1973	76.0	5690	1790
1974	33.0	5690	1400
1975	38.5	4710	1190
1976	76.8	8890	2390
1977	82.5	12000	2820
1978	100.5	14550	3420
1979	20.0	5970	1400
1980	54.1	8300	1950
1981 (as on 19 August)	16.2	2050	480

Sources:

(a) Report of the national Commission on Floods, Vol. 1, Department of Irrigation, New Delhi, 1980

(b) Replies to Rajya Sabha Unstarred Questions 109 (17 November 1980), 1906 (11 March 1981) and 836 (26 August 1981)

Table 6. Annual rates of siltation in selected reservoirs (in acre feet)

RESERVOIR	ASSUMED RATE	OBSERVED RATE
Bhakra	23,000	33,475
Maithon	684	5,980
Mavurakshi	538	2,000
Nizamsagar	530	8,725
Panchet	1,982	9,533
Ramganga	1,089	4,366
Tungabhadra	9,796	41,058
Ukai	7,448	21,758

Source: Report of the Irrigation Commission

Punjab in 1978, when 65,000 persons were rendered homeless, is an obvious example.

A high rate of siltation not only puts pressure on the dams but it also deprives the plains downstream of nutritional benefits derived from the silt which is distributed over the land during floods and adds to the fertility of the soil.

Many of the shortfalls in the intended benefits from dams can thus be traced to the neglect of a number of significant details, such as the proper construction of irrigation canals, distribution losses in power lines and deforestation in the catchment areas. Indians have apparently made an adequate offering at their modern temples; but the "pujaris", the keepers of the temples, appear to have short changed them.

ADVERSE ENVIRONMENTAL EFFECTS

Big dams have had several adverse effects on the environment and the people, which were not foreseen during the planning of these projects. One of the most important of these effects is the degradation of the soil in the command areas of irrigation projects due to increase in soil salinity and water-logging. (See Land chapter)

Destruction of habitat

The construction of several large dams has involved the eviction of thousands of families, and their resettlement at some other site. One of the first major eviction operations related to the evacuation of the town of Bilaspur in Himachal Pradesh which was submerged by the Bhakra dam reservoir. Seven thousand citizens of this town, with modern amenities like a college, a hospital, markets and playgrounds, were displaced. A new township was created on nearby high ground and the displaced persons were given cash to build new houses. Today the new Bilaspur is a flourishing town.

People uprooted by later projects, like the Srisailam dam in Andhra Pradesh, the Kali hydroelectric scheme in Karnataka, the Pong dam in Himachal Pradesh and the Sabarnarekha in Chota Nagpur, to mention a few examples, however, have been made refugees in their own land. The Government's rehabilitation programmes generally offer inadequate financial compensations. They fail to preserve and create the community life of the displaced populations. Instead, the latter are treated as a collection of unrelated individuals in true bureaucratic fashion (See box).

Addressing a seminar organised by the residents of Sirsi in Karnataka, Dr Madhav Gadgil, the eminent environmentalist, described the economic losses of the refugees from the Kali project: "The township of Supa, along with a number of minor villages will be submerged by this project and these several thousand families have to be provided alternatives in lieu of their paddy fields, coconut and arecanut gardens and other rich agricultural and horticultural land. Since practically all of such land is already under cultivation, they have been provided a hectare of non-irrigated hilly land for every hectare of submerged land, which is mostly irrigated lowland... no attempt is being made to provide the refugees with alternative non-agricultural occupations based on the large amounts of electrical power that will be generated by this giant hydel project."

The most glaring example of disregard for the life style of the ousted persons, has been the attempt to resettle evacuees from the Pong dam area in Himachal Pradesh, a hill State, in Ganganagar district of Rajasthan. The latter is a border districts, at the western edge of the Rajasthan desert. Though many of the refugees were given lands irrigated by canals, they soon sold them and returned to Himachal.

A potentially explosive situation exists in tribal areas like the northeastern hill States and the Chota Nagpur area. The people here have a tradition of rebellion and armed insurgency. The current thinking in government circles is to tap the hydel resources of the Brahmaputra river system, in the Northeast, in a big way. If this causes large-scale displacement of unwilling people, it could aggravate the discontent already present in this region, with serious political repercussions.

Srisailam: Pushing out the dispossessed

"The problems arising out of the submersion of villages and agricultural lands by river valley projects affect mostly the poorer sections of the population in the villages." This is one of the conclusions in a report prepared by a fact-finding team sponsored by the Lokayan Research Programme of the Centre for Study of Developing Societies, which surveyed 15 out of the 100 villages affected by the Srisailam dam in Andhra Pradesh.

This gigantic dam across the Krishna river will submerge over 100,000 acres of land, displacing about 100,000 persons. Eighty one per cent of them belong to scheduled and backward castes and about 75 per cent of the households have been marginal farmers or agricultural labourers, according to the Lokayan report. While the landowners received some compensation, which they generally described as inadequate, nothing was paid to the weaker sections who had been surviving for years by cultivating government-owned waste lands.

Ninety-five per cent of those surveyed were illiterate and unaware of the provisions of the Land Acquisition Act (1860). This made them vulnerable to corrupt officials in charge of making compensation payments. On the other hand, many rich and educated persons sued the Government for an increase in compensation. Out of 9417 cases filed, 416 have been settled and the Government has lost each one of them.

The Lokayan team visited the area after government bulldozers had invaded the the villages, razing them to the ground. Scared and disheartened villagers collected their meagre belongings in small bundles and beaten-up trunks and were moved 10 to 15 km away in tractors, bullock carts and trucks. "It was an unpleasant, heart-rending and thankless job," K. Krishnamoorthy, the supervising engineer, told an "India Today" correspondent.

The Srisailam resettlement programme lacks sensitivity to the needs of the young and the old to revive earlier relationships. "Unless conveniences like a school and a drinking water well are provided, we will never be able to live together. The Government must make adequate arrangements so that we are not separated," says Abdul Amin, an uprooted small farmer.

INDIA TODAY/PRAMOD PUSHKARNA

Dam diseases

Another harmful impact of dam building on the people is the increase in the incidence of some diseases. The construction of large reservoirs can elevate the sub-soil water in the vicinity with consequent changes in the levels of calcium and trace metals. This changes the nature of fluorosis, a crippling bone disease, in areas where it is already prevalent. (See box "Crippling cost of big dams" in the Health chapter)

Irrigation reservoirs generally cover a large area with shallow weed-infested edges. The latter provide breeding grounds for disease carrying mosquitos. Malaria occurs commonly among construction labourers, and among the local population later, unless special precautions are taken. Filariasis and Japanese Encephalitis may also appear and become endemic in such areas, "The Raichur district of Karnataka State has become highly endemic for malaria after Tungabhadra's damming and canal network development," says Dr V. Ramalingaswami, Director General of the Indian Council of Medical Research.

Destruction of ecosystems

The design and construction of dams in India have been conducted mainly as civil engineering tasks neglecting their harmful ecological impact. Engineers concentrate on providing the intended benefits to downstream areas. Consequently the environment of the catchment regions upstream has been neglected or wantonly exploited in most cases. Although this ecological ruin has grave long-range economic consequences for the nation, its immediate victims are the tribals, the peasants in the river valleys and the hillfolk, whose lives depend on the resources provided by their immediate environment.

The decimation of vital forests in the catchment areas is one of the most serious consequences of the engineering approach. Large tracts of forests have been lost as a result, particularly in the Himalayan hills and the Western Ghats. Submerging forest lands has aggravated the problem.

The ecological damage done by construction of dams was brought into sharp focus by the campaign against the Silent Valley Hydroelectric Project in Kerala, led by the Kerala Sastra Sahitya Parishad. Silent Valley is a tropical rain forest area at the southern end of the Western Ghats. The specific issue here is the threat of extinction posed by the dam to the tremendous variety of biological species that have evolved over hundreds of millions of years (see box).

The Western Ghats, running parallel to the west coast of India, provide several ideal locations for hydroelectric and irrigation projects. The steep Western slopes receive heavy rainfall and are therefore ideal for generating hydroelectric power. The slopes on the eastern side merge with the Deccan plateau and are best suited for irrigation works. The major hydel projects are the Koyna, Linganamakki, Upper

The Seven Per Cent Solution

Three years ago, the Central government, requested the state of Kerala to abandon the Silent Valley hydroelectric project. But the fate of the unique valley remains undecided as committee after committee goes on reviewing the Centre's decision.

A plan to generate hydropower by damming the Kuntipuzha river flowing through this valley was first considered in 1921. A drop of 857 metres, the highest in the state, makes it an ideal site for a hydel project. Unfortunately it also happens to be one of the few tropical rain forests in the country left undisturbed by the onslaught of modernization. With an evolutionary age of more than 50 million years, the Silent Valley has one of the richest biological and genetic heritages in the world.

Malabar — the region where the Silent Valley is located — is one of the least developed areas of Kerala. The per capita consumption of electrical energy in Malabar is only a quarter of the statewide figure. Many people in this area have been campaigning for the project in the hope that it will provide employment.

The Silent Valley controversy, therefore, presents a classic case study in the environment versus development debate.

"Even a preliminary study of the peripheral areas of the valley has yielded information on over 900 species of flowering plants and ferns. Several specimen that have become extinct elsewhere are found in the Silent Valley," says the Botanical Survey of India. A few plants collected by it are new to science. The vegetation abounds in medicinal and aromatic plants as also wild relatives of spice and pulse yielding plants. The latter have shown an enormous amount of genetic diversity with respect to disease resistance and protein content.

The Zoological Survey of India has identified several rare and endangered faunal species including butterflies, birds, fish, amphibians, reptiles and mammals in the Silent Valley. Three amphibian species were previously unknown. Many insects and birds like the Black-orange Fly-catcher, the White-browed Bulbul, the hill Myna and the Hornbills are endemic to this area. Three endangered mammals, the Lion-tailed Macaque, the Tiger and the Nilgiri Tahr are also found here. The Lion-tailed Macaque is one of the most endangered mammals in the world. (See Wildlife chapter).

"We cannot afford ecological luxury," commented Vasudevan Nair, then Kerala's Chief Minister, in reply to a note from the International Union for Conservation of Nature (IUCN), requesting the state government to "save the Silent Valley". But the plant genetic diversity is an immense economic resource that the state can ill afford to lose. Genes from the wild plants, which have undergone a fantastic natural selection process, can be cross-bred in cultivated crops to incorporate disease resistance and drought endurance characteristics.

The Kerala Sastra Sahitya Parished (KSSP) acknowledges that for the people of Malabar, their needs for energy, irrigation and employment are more real and obvious than the necessity of protecting the Silent Valley. But it counters that, "The total demand for electricity in Kerala by 1990-91 will be about 7,730 million kwh, to which the Silent Valley, when and if completed will contribute only 522 million kwh or a mere seven per cent — so, from the point of the overall energy position, either of Kerala or of the southern grid, in the short as well as the long term point of view, the Silent Valley project is only marginally significant."

In 1979, Dr. M.S. Swaminathan, then Secretary, Ministry of Agriculture and Irrigation led a study team of government officers to Silent Valley. In his report he concluded that the immediate needs of Malabar could be met by extending the power transmission lines from the Idduki project. Dr Swaminathan also recommended that groundwater resources in the area be tapped to irrigate the 10,000 hectares to be served by the dam.

In 1979, the Department of Science and Technology also pointed out that a hydel project across the Barapuzha river would better serve the needs of the Malabar region. A thermal power station was offered as yet another alternative.

The campaign against the Silent Valley dam has brought together a remarkable number of individuals and organizations. The list of organizations includes among others, the KSSP, the National Committee on Environmental Planning (NCEP), the Bombay Natural History Society, World Wildlife Fund-India, Friends of the Trees, IUCN, and the press.

The Silent Valley has become an international cause celebre. But the Kerala politicians remain adamantly in favour of destroying their 50 million years old heritage for a a seven per cent solution.

Bhavani and Idduki dams. The irrigation works include the reservoirs at Panshet, Kabini and Bhavanisagar. "These projects have sharply diminished the biological diversity of this region," points out Dr Madhav Gadgil.

The lessons of the compaign against the Silent Valley project appear to have been lost upon the authorities who have planned the 480 MW hydroelectric project at Vishnuprayag, in Garhwal. It will seriously threaten the unique flora of the Valley of Flowers and the neighbouring Bhyundar Valley. This news comes at a time when the Department of Environment is planning to declare the Valley of Flowers as a protected Biosphere Reserve. In recent years the flora in both these valleys has been under considrable pressure because of the increasing number of tourists and Hindu pilgrims journeying upto the shrines at Badrinath and Joshimath. The opening up of new roads and the heavy increase in motor vehicles will add to the stress.

Rapid deforestation in the catchment areas leading to increased soil erosion, landslides and consequently heavier water flows into the reservoirs, imperils river valley projects in the Himalayan, Western Ghats and Chota Nagpur regions. Analysing the threat to the the massive Tehri dam, Dr S.P. Nautiyal, a former Director-General of the Geological Survey of India, says, "The Bhagirathi and the Bhilangana rivers drain the southern slopes of the central snow-covered Himalayas, where erosion is extraordinarily active and the river brings silt for eight months in year. The hill sides of the catchment area have been denuded of vegetation leading to heavy erosion. The proposed life of the Tehri reservoir may turn out to be only 30-40 years instead of 100 years."

In addition to forests lost in the catchment and submersion areas, they have also been cut down in ill-planned attempts to resettle evacuees. Dr Madhav Gadgil describes the ruin of a reserve forest to rehabilitate refugees from the Kali hydroelectric project: "At the time of handing over this land the entire tree crop was removed and the land was allowed to lie fallow for a long time without any soil conservation measures being undertaken on it ..... Meanwhile the topsoil on these uprooted hill slopes in this catchment area of one of the Kali Project reservoirs has eroded over the last four monsoons making it by 1979 a desert unfit for cultivation for all times". The original forest was rich in the Terminalia tree species which could have been used to support tasat silk industry, beekeeping and other activities based on minor forest product for the settlers.

Large-scale deforestation for dams can lead to subtle imbalances in the ecosystem. In the Kali project area, there has been an enormous increase in the population of the weed *Eupatorium glandulosum*. This weed smothers all tree growth in clear felled areas and is totally unpalatable to all herbivorous animals. It also renders forests more susceptible to fire and to mineral losses through leaching.

Following the construction of dams, aquatic life is often grievously harmed. Changes in water velocity, water chemistry, temperature and turbidity disturb the free passage of fish to and from their spawning grounds. Weeds often proliferate in irrigation reservoirs. Many of these weeds can spread diseases among human beings and cattle.

Construction of dams on many rivers have made many of them lifeless, especially the smaller ones. The impounding of river waters in reservoirs has reduced the flow in many rivers to a trickle. They are thus unable to withstand the ever-increasing pollution load. The Upper Ganga Canal diverts so much water at Haridwar, that the meagre flow remaining in the mainstream cannot absorb the pollution load at Kanpur.

The Beas is a lively young river as it riples along the Kulu Valley. After its waters are diverted at Pandoh, near Mandi, the river becomes a dirty, dull and lifeless stream. Tourist brochures published by the Himachal Pradesh Government, talk about the wonderful trout fishing at Nadaun, further downstream in the Kangra Valley. Even though the Beas is broader here, strenthened by a few mountain streams; there are hardly any trout here. And the residents of Nadun do not care to stroll along the river banks any more, or swim in it.

Earthquakes and dam bursts

Dams can also create several hazards which are very significant but not so well-known. Scientific research conducted at several large reservoirs has revealed the possibilities of earthquakes being triggered due to the impounding of massive amounts of water in them. Seismic tremors have been recorded at these reservoirs. Earthquakes can also occur due to the existence of active faults, or discontinuities in the underground rocks, along which movement may take place, or due to the existence of fissures through water seepage into the earth.

In a study titled, "Reservoirs and Earthquakes," its authors Harsh Gupta and B.K. Rastogi cite about 30 cases, "where the initiation or enhancement of seismic activity has been well evidenced following the impounding of reservoirs behind large dams."

The reality of these hazards was highlighted after the devastating earthquake which struck Koynanagar, 450 km southeast of Bombay on December 10, 1967. This region had long been a non-seismic one, but had experienced a series of tremors after the impounding of water in the Koyna dam reservoir in 1962. In the 1967 earthquake nearly 200 lives were lost, 1500 people were injured and thousands were rendered homeless. More than 80 per cent of the houses in Koynanagar were either completely destroyed or bcame uninhabitable. The city of Bombay and its suburbs were also rocked. The generation of electricity from the Koyna hydel works was badly affected, paralysing Bombay's industry.

Whether a dam will collapse or not during an earthquake, depends on several factors. These include the type of foundation rock, its vibration characteristics and the presence or absence of faults or recent seismic activity. Such factors are normally taken into account in preparing the design of a dam. Even though the Koyna dam actually moved in the 1967 earthquake, the huge structure did not collapse.

A more sensible approach is to thoroughly investigate a site, where a large dam is to be constructed, for potential earthquake hazards, as part of the environmental impact analysis. The need for caution is especially great in regions that are known to be geologically unstable, such as the Garhwal Himalayas. The Tehri dam which is being constructed here is one such example (See box). Similarly, extremely careful evaluations will be necessary for the many reservoirs planned in the Brahmaputra river system in Northeast India. Seismologists have predicted a high probability of strong earthquakes in this region in the next few years.

There are also cases of bad designing and poor quality of construction leading to dam bursts. The worst dam disaster in India was the bursting of the Machu dam in Gujarat in 1979. Several hundred people were killed and the town of Morvi, alongwith several villages was destroyed by the flood waters. According to the Consumer Education and Research Centre (CERC), Ahmedabad, the dam was designed using an outdated empirical formula. The Central Water and Powr Commission had thrice asked the State Government to use a more scientific formula. State Government sources maintain that the dam failed due to extremely heavy rainfall and floods in the spillway.

There is an interesting sidelight to the Machu dam burst. In March 1981, the present Government of Gujarat summarily wound up the inquiry commission appointed to look into the cause of the disaster. CERC filed an appeal against the Government's decision in the Gujarat High Court on the basis that the public had a right to know the findings of the commission. The High Court ruled in favour of CERC's plea. The ruling is being appealed by the State Government in the Supreme Court. The curious aspect is that the present Chief Minister of Gujarat was the person who had demanded the appointment of the commission in 1980, when he was the leader of the Opposition in the State Assembly.

There are several cases of undesirable seepage in various dams across the country, according to press reports. Disturbing reports have appeared about the Barna dam near Bhopal and the Bargi dam near Jabalpur, both in Madhya Pradesh. The Somasila dam across the Pennar river in Andhra Pradesh has also developed cracks in the spillway.

The well of water that is unleashed when a dam, reservoir or a tank bursts, packs tremendous force that can wipe out everything in its path. Even a relatively small tank burst, such as the one on October 19, 1981 at Gopinatham in Karnataka, can be devastating. The two million cubic metres tank had been built in November 1980 at a cost of Rs 40 lakhs. Within minutes of its breach, the entire village of Gopinatham, with a population of a few thousands, was wiped out, leaving over 40 dead and the rest homeless.

The State Government was quick to call this a "natural calamity", blaming a sudden storm that had hit the area a few hours earlier. A later investigation by the State's Public

Is Tehri dam a time bomb?

The sleepy Himalayan town of Tehri woke up four years ago to the fact that a project undertaken for the betterment of their region could lead to disaster. The subject of controversy is the construction of the Tehri Dam, 1.5 km downstream from the point of confluence of the Bhagirathi and Bhilangana rivers and about 80 km north of Rishikesh in Uttar Pradesh.

The dam, to be formed with rocks and rubble, technically termed a rock-fill dam, will be 260.5 metres high, making it the fifth highest of its kind in the world. It is being constructed to serve a dual purpose. It will generate hydroelectric power with an installed capacity of 2000 MW, and provide water for irrigating 668,000 hectares of land.

But geo-scientists and environmentalists suggest that the size of the dam and its location could trigger an earthquake in a seismically active area. Also, the heavy rate of siltation of the snow-fed rivers could create such stresses that the dam could collapse.

To press their points home, those objecting to the construction of the dam formed a Tehri Bundh Virodhi Sangharsh Samiti in 1978 and have campaigned against the decision to build the dam, In the Samiti are geologists and scientists who point out that the site selected is unsuitable because of the highly fissile nature of the rocks there and the presence of fissures and faults in the rock bed. Combined with the tectonic history of the Himalayas, the youngest mountain chain in the world, the construction of such a high dam in the region could be dangerous.

V.D. Saklani, president of the Virodhi Samiti, says that even the most solid rocks in the river gorge have been found to contain open joints, weak zones, fractures, fissures, cleavages and other tectonic features. Once the dam is filled, there will be excessive water seepage which will weaken the structure; the dam could collapse just as the rock-filled Teton dam broke in Idaho, USA in June 1975.

A concrete dam was ruled out in the area because of its seismicity and rock condition. But this very fact, say the scientists, makes even a rock fill dam, which is usually built across a much wider valley, a precarious proposition. The location of this dam is across a narrow gorge. The pressure of 3.2 billion tonnes of water impounded in the reservoir could trigger off an earthquake bigger than the 1967 earthquake in Koyna, Maharashtra, which led to great loss of life and property.

Another important hazard is the rate of siltation of the Bhagirathi and the Bhilangana, both snow-fed rivers with their sources in glaciers, which carry large quantities of fine silt and boulders. The siltation rate of the Bharigathi and Bhilangana has been assumed to be 110 acre feet in 100 square miles in one year. giving a life span of about a hundred years for the Tehri dam. Similar assumptions about other large dams, however, have proved to be vastly conservative making their actual life spans much less.

The location of the Tehri dam, in a narrow gorge, and the building materials needed for it, namely granite, quartzite, sandstone etc, have created additional problems. The materials are not locally available. The narrowness and the steepness of the location make transportation difficult. Construction of roads and building activity have loosened rocks and caused landslides. Road-building also leads to cutting down trees, which will worsen the soil erosion and siltation problems.

Officials dispute all these objections. The Geological Survey of India carried out extensive surface and sub-surface investigations of the area from 1960 to 1969 and established the technical feasibility of the project. Officials say that the Tehri dam site is situated in a comparatively less seismologically active part of the Himalayas and that a rockfill dam is in any case an earthquake resistant structure. Increase in seimic activity after construction of large dams has been observed in only 15 out 425 large dams built in the world.

The official figures about the number of people who will be displaced by the dam construction and the number quoted by the Virodhi Samiti vary greatly. The Government says only about 32,000 people will be affected in Tehri town and 92 villages; the Samiti claims up to 70,000 people will be displaced. The process of relocation will mean further deforestation. The Government has offered attractive compensation of landowners whose lands will be submerged and also to the landless; Tehri town itself will be relocated at a higher level. This offer partly explains why the local populace in Tehri has not backed the Virodhi Samiti in a sustained manner and the movement has dissipated.

All the objections notwithstanding, work on the dam continues. When it began in 1968 the cost was estimated at Rs. 175 crores. In 1979 it was revised to Rs. 827.70 crores and by the time the dam is ready — not before 1990 according to some estimates — the cost will be even higher.

The Virodhi Samiti, even if it has not been successful in stopping work on the dam, has raised relevant ecological issues. It has suggested alternate schemes, including smaller hydroelectric projects that do not cost so much and are less harmful to the environment. They have also drawn attention to the fact that despite such a large expenditure, and resettlement of so many people, the life of the dam and the time span over which it can be of service is likely to be restricted.

The controversies over the benefits and hazards of the Tehri dam reveal that its environmental impact has simply not been studied thoroughly .

From village to graveyard: On October 19, 1981, an irrigation water tank near Gopinatham split open after heavy rains. A wall of water smashed into Gopinatham, killing 47 people and rendering 300 homeless. (India Today/Bhawan Singh)

Accounts Committee concluded that corrput officials and contractors were responsible for shoddy worksmanship and that proper maintenance could have averted the tragedy.

If the Karnataka Government had any genuine concern for human life, it would have willingly ordered a thorough investigation. Instead, by being evasive and uncooperative, it only compounded the criminal neglect of its officers and contractors.

COST BENEFIT ANALYSIS

India has spent about 14 per cent of its total plan expenditure on dams and canals. "A single activity of this magnitude should not continue to proceed on largely untested assumptions and beliefs, and a continuous verification of the estimates should be made necessary for every large or medium project. But no attempt has been made to revise or verify these beliefs," says Vijay Paranjpye.

The Planning Commission's criterion for approving dam projects is that the cost-benefit ratio should be at least 1:1.5. The preceding sections have shown clearly that in most cases, the benefits fall short of the intended targets while the costs escalate. At a high-level meeting convened recently by the Planning Commission, where voluntary organisations were also invited, it was observed that the feasibility reports submitted to it for approval, often contained estimates that oversatisfied the criterion. Obviously the sole purpose of this was to win the Planning Commission's approval.

Paranjpye led a survey team to study the Bhima Project in Maharashtra. They concluded that by the time all the project expenses had been incurred, the benefit/cost ratio had been reduced from 6.29 to 0.9. "However, if the special cost of rehabilitation and demage to the environment were also quantified — the ratio would fall to as low as 0.46:1," said Paranjpye.

The recent high-level review meeting called by the Planning Commission probably represents the first effort in a Third World country to take a fresh look at the costs and benefits of large dams. Many engineers and administrators who are in charge of actually implementing the projects, however, are still a long way from being convinced that environmental costs are significant.

Alternatives

To point out the various hazards and environmentally harmful impact of dams does not imply recommending a ban on all such projects. It simply draws attention to environmental concerns that have been ignored so far. Various authorities have stressed that dams are essential for meeting the developmental needs for irrigation and power. But development without destruction is possible. The first step is obviously to make this a guiding principle in the planning and design of such projects.

The second step is to achieve a fuller utilization of the

Damming the tribals

The construction of dams has effectively resulted in a direct assault on the country's tribal population. Dams are usually constructed in remote, forest areas, where most of the tribal groups also live. The sudden influx of the modern system, destruction of the surrounding nature on which their lives are dependent, and ultimately displacement and resettlement, leaves a tradition-bound tribal family totally bewildered, powerless and on the verge of total social, cultural and economic collapse.

For the 7770 tribal families which are going to be displaced by the multipurpose dams being built across the river Indravati in Orissa, the future has become a big question mark. The districts of Koraput and Kalahandi have a large tribal population and are generally regarded by official agencies as extremely backward districts. Land was first acquired in the region for the establishment of two big factories: the Sonabara-based National Aluminium Company (NALCO) and the Koraput-based Hindustan Aeronautics Limited which produces MIG aircrafts. These two factories have certainly given a boost to industrialisation and urbanisation in the region but they have also unsettled many tribal families. The Indravati dams will submerge some 99 tribal villages and the people living in these villages are obviously afraid that they will be treated with equal disdain.

The proposal for a series of dams on the Indravati was first accepted in 1961. Preliminary surveys were carried out for several years and finally project work began in earnest in 1978.

The rehabilitation programme, which the government has adopted at least on paper, has been developed after carefully taking into account the facilities provided to dam oustees in other projects in Orissa and other states. The displaced families will be given free house sites, agricultural land, assistance for housing construction, electrification and minor irrigation, and common facilities like village roads, schools and drinking water wells will also be built. However, no land has yet been acquired to rehabilitate the affected people. A survey of the submersion area and a listing of the displaced families is in progress.

A case study of the already displaced village (which lies closest to the project site) carried out by Chittaranjan Mohapatra and Dr N.K. Bewara of the Department of Anthropology at Utkal University, shows the lack of vision with which the resettlement work is carried out. Patradora consists of 23 Penga and one Dom household. This village was earlier situated adjacent to the main dam site; when the villagers complained that the blasting operations were affecting them, the project authorities decided to shift the village temporarily. In 1980, the villagers were resettled 200 yards away from the old site. They have been allotted new houses at the cost of the project. The old settlement pattern of the village has been retained and facilities have been provided in a way to reduce inconvenience. The dam contractor has also given the villagers priority for jobs as labourers and supervisors.

It is still very difficult to find out whether the villagers were resettled by force, or by friendly persuasion. Blasting work on the river bank had so terrorized them that they had no alternative but to accept the dictates of the contractor. A village meeting was held and the leaders of the village were ultimately convinced that shifting immediately was the best alternative. The promise of getting work was an extra allurement. However, farming members of the village still find it difficult to move about during working hours because of the blasting operations. A fear psychosis constantly haunts them. They cannot go out and return anytime. This poses a serious threat to children and drunkards, of whom there are many.

Although the old village pattern has been retained, the village priest is not happy with the new settlement because of his social position as the supreme religious authority has been vitiated. Since many villagers now work as wage earners on the dam site, and because of the discontent of the village priest, the villagers now apprehend natural calamities and havoc in future. For proper appeasement of village deities, the Jani (village priest) must be of healthy mind. Rituals are not being performed properly. The villagers also do not want the Jani to work on the dam site as evil spirits may enter his body and affect all the villagers as it is the Jani who controls the deities. For this reason the Jani does not work on the dam.

The tribals also claim that the compensation promised by the project authorities has still not been given to them. The delaying tactics have made them lose faith in the authorities. However, no formal complaint has yet been made. The villages which are going to be submerged exhibit many conventional features of tribal groups: polygamy, capture marriages, payment of bride price, belief in witchcraft and sorcery, social solidarity on the basis of kin obligations, a common food habit of taking millet gruel (Mandia), and hereditary acquisition of political and religious positions. The economy is largely at the subsistence level. Tribal deities reign supreme at the village level. Annual festivals and rituals revolve around agricultural operations. The basis of mutual co-operation and service relations is generally not economic but social and cultural. However, the new developments in the region have increased heterogeneity in these populations.

There are several apprehensions about the resettlement programme. The villagers here know that they will be given lands for resettlement and cultivation. But they are not very sure of the type of land and area. Their anxieties increase when they see existing valuable pieces of land which they will lose. Loan sharks have already begun to recover loans from the tribals, even though their actual displacement may be 20 to 30 years away — especially if the project is delayed, like most dams in India.

Most of the Pengas — whose socio-economic status is low even amongst most tribal groups — have traditionally depended upon shifting cultivation for their subsistence and land is meagre. However, the forests supplement their needs in many ways. The Pengas are avid collectors of roots, tubers, fruits and wild greens. Kuna, a local tuber, is often used by them as a staple during the lean season. The Pengas are not sure if they will have access to a suitable forest, if at all, when they are rehabilitated.

The strong attachment to the parental lands has created in the tribals a group feeling which has now become virtually sacred because of ancestral warfare. The displacement will thus amount to sacrilege and, the tribals fear that this could shatter their social life. Earlier, they used to perform adhoc rituals before the establishment of a new village and only if omens were good, the site on which the ritual was performed was selected for settlement. But this will not be permitted in the case of the resettlement sites. The villagers are also anxious about how they will be able to take their dieties to the resettlement areas alongwith them.

Most villagers are certainly afraid that the inhabitants of one village may be rehabilitated in different villages and then they may not be able to pull on well with their new neighbours. Quite often this point of view has been discussed in several village meetings.

Construction of the dams no doubt is the major undertaking of the project. But the resulting effect after the completion of the project in part poses serious threats to the life and activities of the populace of the area, which is a human problem. The lack of communication between the people to be displaced and the dam authorities has further aggravated these anxieties. The tribals are looked down upon by the officials, who believe that they can manipulate them in any manner they like. Few attempts have been made to discuss and convey information to the local people. In the absence of this communication, the tribals' own leaders often begin to prey upon their fears. Cases have been found where they spread horror stories to serve their own vested interests. Funds are raised on various pretexts which go straight into their pockets. Meanwhile, many villagers don't even really know what is the purpose of the dam.

benefits of the dams that have already been built. This requires a greater attention to delivery systems. "The cheapest form of alternate energy is energy saved," says the Sixth Plan document. Reduction in the transmission and distribution losses of power can significantly increase the availability of power. These losses at present amount to over 40 per cent of the installed capacity, nearly 5000 MW, that will be added during the Sixth Plan. Quick construction of canals and lining them properly, to minimize seepage and water logging problems, can substantially increase crop yields from the command areas of irrigation projects.

The third step is to seriously look for alternatives to gigantic projects. Groundwater resources development offers a number of environmental and economic advantages over major irrigation schemes. (See Land chapter). Small scale hydroelectric plants can be very useful in augmenting the country's available hydroelectric potential and in providing electricity in remote areas, particularly the hill districts.

Small hydel works require relatively short water drops. Since the transmission is over short distances, distribution costs and losses are relatively low. They have shorter gestation periods and have a negligible impact on the enviroment. They are relatively easier to operate and maintain. A survey of India's hydel resources, by the Central Electricity Authority, estimated the small hydroelectricity potential of India at 25 billion kwh, which is about 60 per cent of our present installed capacity.

Indian planners, however, have so far shown disdain for small hydel schemes. The Sixth Plan has no specific allocation for small hydro power projects. Some micro hydel units exist in Uttar Pradesh besides experimental ones in a few other places.

By contrast, in China, 87,000 small hydel works generate almost a third of its total hydropower. They require a drop of less than 10 metres for an average installed capacity of 57 kw. The total amount of power produced by these small units in China is more than half the current installed capacity of all the hydroelectric projects in India.

Small hydroelectric projects would not only meet "a social requirements but (also create) conditions for the overall development of the remote regions," explains a report of the Planning Commission's Working Group on Energy Policy. But these plants can only serve the nearby rural populations. Micro hydel schemes, therefore, run counter to the current trend of large centralized projects, the lion's share of whose output is fed to urban-based industries. This is perhaps the real reason why small hydroelectric projects have not been taken up in India.

Why have the environmental costs of large dams been ignored to far? One reason is that our planners and engineers are mainly rooted in urban India. Their lives are far removed from a direct dependence on natural resources. The negative impact of such projects is mostly borne by tribals, peasants and the hill folk, whose daily lives depend closely on their immediate environment. Dr. Madhav Gadgil suggests that the interests of these weaker sections of our society should be used to determine whether a project is environmentally sound and whether it will promote a balanced development process. "If these interests are given serious consideration, we will orient ourselves towards planning . . . for true, sustainable development."

ATMOSPHERE

- *While air pollution levels in several major cities of the West are going down, in India they are going up.*

- *Levels of sulphur dioxide and particulate matter in several Indian cities already exceed permissible limits set by the World Health Organisation.*

- *India's premier pollution research institute claims that 60 per cent of Calcutta's residents suffer from respiratory diseases because of air pollution.*

- *For the inhabitants of Bombay, Chembur has now become 'Gas Chembur.' The locality as one of the highest concentrations of chemical industries in India.*

- *The biggest environmental problem to face the world may come in the form of unpredictable climatic changes caused by alarming increases in atmospheric carbon dioxide levels.*

- *An increase of 1-2°C in average world temperature could mean in India more heat and drought in summers and more rain and floods during the monsoon season. The result could be disastrous for agriculture.*

- *The increase in atmospheric carbon dioxide is because of increased use of fossil fuels for industrialisation. Developed countries account for 75 per cent of the world's output of carbon dioxide.*

5

ATMOSPHERE

In his book "The Lives of a Cell", Lewis Thomas vividly describes the earth as a living cell and the atmosphere as a protective membrane around it. The atmosphere helps retain air above the surface of the earth. Air is a precious natural resource without which life cannot be sustained for more than a few minutes. Yet, the concern for clean air and protection of the atmosphere from damage by human activities is only a recent phenomenon.

Human activities like industrial production, motor transport and domestic burning of fuels are adding large amounts of harmful pollutants to the atmosphere, triggering off a host of global and regional environmental problems. A report of a World Health Organisation (WHO) Expert Committee warns: "The earth's atmosphere is finite, and its capacity to cleanse itself, although as yet imperfectly understood, seems to be limited ....."

On the global scale, a steady increase in the carbon dioxide content of the atmosphere holds out the threat of catastrophic climatic changes, in less than a half-century from now.

"The carbon dioxide question was undoubtedly the largest outstanding environmental problem confronting the world at the end of the 1970s," says the decadal report on the the World Environment 1972-82 by the United Nations Environment Programme.

At the local level, the harmful effects of air pollution include noxious fumes and odour, diminished visibility, injury to human health, crops and other vegetation. It also damages property by dusts and corrosive gases.

Air pollution is no longer a problem confined to over-industrialised cities in the distant West. After engulfing the large cities in India, it has begun to hurt the residents of small towns and once sleepy villages where thermal power stations and large industries are now being located.

It is ironic, therefore, that public awareness of the need to control air pollution remains low in India.

AIR POLLUTION

"Air pollution is unhealthy for children and other living things," says a hand-made poster in the house of a Chembur resident in Bombay. This is, in fact, the politest statement that can be made about this nuisance that people there have to face everyday. It is not surprising that Chembur, with one of the highest concentrations of chemical industries in the country, is now called "Gas Chembur" by the local inhabitants.

Many other cities of India are not far from becoming gas chambers. India is fortunate in that its "coal is low in sulphur content, the number of automobiles is relatively small and the rainy season is an effective scrubber for mitigating air pollution," says the environment section of the Sixth Five Year Plan document. But it also readily admits: "Despite these advantages, problems of air pollution are becoming severe in major cities like Calcutta, Bombay and Delhi ..... levels of sulphur dioxide and particulate matter in certain major cities exceed permissible limits set by organisations like WHO."

Air pollution first attracted national attention in India, at least among the newspaper reading public, in 1972, when the Government announced plans to built an oil refinery in Mathura, just 40 km away from the Taj Mahal. The threat to the Taj Mahal is the most documented air pollution case study in India (see box).

In contrast to the attention focussed on the Taj Mahal problem, little is known about the extent and impact of air pollution in the rest of the country. In the small towns and villages, it affects people and agriculture. Prof D.N. Rao of the Banaras Hindu University told a national conference on air pollution earlier this year that depending upon the emissions of an industry, the agricultural yield can come down by as much as 17 to 30 per cent. He added that plant life in Mirzapur district in UP, had "suffered immensely due to pollution."

Table 1. Estimates of pollutants (in kg) emitted by non-commercial fuels (in tonnes)

	Firewood	Cattle dung	Agricultural wastes
Carbon monoxide	1.63	0.69	1.59
Sulphur dioxide	19.60	8.18	18.75
Nitrogen oxides	3.90	1.63	3.75
Organics (including hydrocarbons)	23.50	9.81	22.05
Particulars	31.40	13.09	30.00
Hydrogen sulphide	1.20	0.45	1.12
Ammonia	1.20	0.45	1.12
Hydrogen chloride	1.20	0.45	1.12
Total	83.63	34.75	79.50

Source: J.K. Parikh, Department of Science and Technology, Government of India, 1976.

No comprehensive study has been undertaken of even the large Class I cities, with populations of over 100,000 each. In 1970 the Central Public Health Engineering Research Institute (CPHERI) in Nagpur, released the results of an air pollution survey covering nine major cities. The National Environmental Engineering Research Institute (NEERI), the former CPHERI, published a report on "Air Quality in Selected Cities of India" based on data collected in 1978 and 1979. This survey covers 10 major cities (Table 2).

Laws for local control of air pollution have existed since long in Calcutta (1905), Bombay (1912) and Kanpur (1958),

Table 2. Basic data on air quality in selected cities (in micrograms per cubic metre).

CITY	Suspended particulate matter 1970	Suspended particulate matter 1979	Sulphur dioxide 1970	Sulphur dioxide 1979	Oxides of Nitrogen 1979
Ahmedabad	307	243	11	71	NA
Bombay	241	275	47	83	23
Calcutta	341	578	33	85	24
Cochin	NA	110	NA	15	NA
Delhi	601	481	41	39	38
Hyderabad	146	295	5	26	16
Jaipur	446	379	4	17	10
Kanpur	544	344	12	25	9
Madras	101	106	8	16	12
Nagpur	262	386	8	12	22

1. Maximum acceptable level of suspended particulate matter (ISI standard) : 150 micrograms/cubic metre.
2. Maximum acceptable level of sulphur dioxide (ISI standard) : 60 micrograms/cubic metre.
3. Maximum acceptable level of oxides of nitrogen : standard not yet established.
4. Cochin was the tenth city included in the NEERI report. Only limited data for 1979 were given.
5. Data are not available about levels of oxides of nitrogen in 1970.

Sources: For 1970 data, CPHERI, Nagpur; For 1978-79 data, NEERI, Air quality in selected cities of India, Nagpur.)

among other places, in the form of Smoke Nuisance Acts. The Central Air (Prevention and Control of Pollution) Act, 1981 is the first enactment of national legislation in this field in India.

MAJOR POLLUTANTS

The WHO defines air pollution as a "situation in which the outdoor atmosphere contains materials in concentrations which are harmful to people or their environment". In the Indian context, this definition is incomplete. It ignores the health hazards posed by indoor burning of non-commercial fuels, including wood, cowdung, agricultural wastes, etc. This contributes a lot of smoke and particulate matter at low ground levels.

The main products of burning fossil fuels are carbon dioxide ($C0_2$), carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), suspended particulate matter (SPM), hydrocarbons and metallic traces. Other specific pollutants arise from particular sources, for instance urea dust from fertiliser factories, lead from automobile emission, fluorides from aluminium production, cement and lime dust from cement plants, radiation from nuclear power stations, etc.

The common sources and environmental effects of some major pollutants are listed in Table 3.

Dr N.L. Ramanathan, Director of the Department of Environment (DOE), points, out, "Specific pollutants are more often than not, recoverable products or by-products". Fly ash, the major pollutant from thermal power stations, can help to reduce the quantities of cement used in plastering walls etc. Kerosene vapours, from textile mills, represent another precious resource vented as a pollutant.

Thermal power stations

Thermal power stations contributed about 60 per cent of the nation's power supply in 1980. There are over 75 major plants in the country today. By the end of the Sixth Plan, additional units will raise the share of thermal power to 65 per cent. These stations also rank among the worst air polluters in the country.

Thermal power stations in India are entirely coal fired. The main effluents from these plants are fly ash, soot and sulphur dioxide. Indian coal has a low sulphur content, generally less than one per cent, but a high ash content, in the range of 25 to 40 per cent. A typical 200 MW station using low sulphur coal emits about 50 tonnes of sulphur dioxide and even higher amounts of soot.

Adequate efforts have not been made to control this pollution in India. The older plants are fitted with mechanical dust collectors which have operating efficiencies of around 70 per cent. Electrostatic precipitators (EP) can perform with upto 99 per cent efficiency, reducing the emissions to a thin white plume of smoke. They are expensive — their prices range from Rs 1-3 crores and have been avoided in the past. Even when installed, EPs are not maintained properly. This cuts down their efficiency sharply. The Indraprastha thermal power station in the heart of New Delhi is a notorious example.

The low sulphur content of Indian coal reduces the conductivity of fly ash and, hence, the efficiency of electrostatic precipitators. To overcome this problem, atomized sulphuric acid can be introduced.

Smaller counts of fly ash can reduce visibility whereas higher counts cause respiratory stress and diseases, including tuberculosis. Inside the Indraprastha power station, the air is heavily contaminated and the walls are blackened with soot. Preliminary results of a survey of the workers there, by the New Delhi Tuberculosis Centre, show that TB incidence among them is about twice the normal levels.

Painted black

The smaller cities and the rural areas around them, where thermal power stations have been located, are often badly hit by air pollution. The 440 MW thermal power plant at Bhatinda in Punjab produces about 1200 tonnes of fly ash: about one kg per resident. "Today the city lies under a permanent blanket of smoke, fly ash coats every surface and a good deep breath is likely to wind up a racking cough," says a report in "India Today". Its electrostatic precipitators have broken down six years after installation. The Punjab State Air Pollution Control Board estimates that the plant emits about 240 to 360 tonnes of ash each day.

Crops on thousands of acres in the vicinity of the power plant are being damaged, according to a State agriculture department official. A local physician reports a steady increase in nasal, eye and respiratory disorders in the last few years.

The power plant's management denies the pollution problems but has plans to install new precipitators. In typical bureaucratic fashion, it is moving at a snail's pace to acquire the EPs. Concerned citizens have formed an anti-pollution committee. After unsuccessful efforts to get relief from State ministers and officials, they are now trying to mobilise public opinion locally.

A cruel irony is that Bhatinda gets no power from the plant.

Thick black smoke, heavily laden with fly-ash due to breakdown of electrostatic precipitators, pours out of the Indraprastha thermal power station, New Delhi. (WHO)

Requiem for the Taj?

Just 40 km from the priceless Taj Mahal, a gigantic oil refinery has been set up outside Mathura City. It will go into full production later this year and will process 6.2 million tonnes of crude oil each year. Some environmentalists claim that the pollution caused by the refinery will slowly destroy the Taj Mahal. Government officials deny the possibility.

The controversy arose soon after the report of the Site Selection Committee became known in the early '70s. Environmentalists complained that the report had based its conclusions on techno-economic factors and had totally ignored environmental issues. Environmentalists like Prof J.M. Dave, dean of the School of Environmental Sciences at Jawaharlal Nehru University, Prof T. Shivaji Rao in Waltair and the Indian Heritage Society expressed grave fears about the likely corrosion of marble and sandstone monuments in Agra, Fatehpur-Sikri, Mathura and Brindavan.

After laying the foundation stone of the refinery, the Government appointed an Experts Committee in 1974 to recommend measures to minimize the pollution from the refinery. Obviously it was not to go into the advisability of the refinery itself, since that was a *fait accompli.*

The Committee commissioned a number of studies by NEERI, the Indian Metereological Department (IMD), an Italian consultancy firm called Techneco and also sought the advice of individual experts.

According to NEERI, the sulphur dioxide concentration in Agra varies from a peak of about 40 ug/m^3 in winter to a low of 7 ug/m^3 in summer. The average value is less than 20 ug/m^3 — well below the ISI standard of 60 ug/m^3. The IMD and Techneco investigations claimed that sulphur dioxide levels would increase by about 3 ug/m^3 only, assuming an emission rate of one tonne per hour. Hence the refinery posed no threat to the Taj. Techneco also concluded that the present discolouration of marble and sandstone of monuments in this area was due to algae and fungi and not pollutant gases.

The committee, however, added that the threat to the Taj could be minimised by controlling the normal pollution in Agra. The major sources identified were two thermal power stations, a railway locomotives yard and about 250 foundries. On its recommendation the thermal power stations have been closed down and the coal burning locomotives replaced by diesel burning ones.

Prof Dave estimates that the refinery will emit 25-30 tonnes of sulphur dioxide, 100-150 tonnes of carbon monoxide, 60-100 tonnes of hydrocarbons, 100 tonnes of nitrogen oxides and trace metals like vanadium, nickel, cadmium and chromium. The north-westerly winds during October to March will transport these pollutants from Mathura to Agra. A serious danger will arise from sulphur dioxide which could combine with atmospheric moisture to form sulphurous or sulphuric acid, both highly corrosive substances. In moist tropical air, says Dave, acid particles do not diffuse like sulphur dioxde and can be transported 100 to 300 km.

The phenomenon of formation of acid in the atmosphere which later comes down in raindrops has been called "acid rain". It is already an acute problem in Northern America and Europe. Crops and forests in Canada are being destroyed by the acid rain due to pollutants emitted by industries in northern USA. Fish in the lakes of southern Norway have been virtually eliminated by acid rain. No study has yet been undertaken in India on this effect of acid rain on plant and animal life.

"Increased acidity will definitely damage the marble of the Taj irreparably over a period of 50 to 100 years. The delicate carved projection may crumble even earlier, being converted into gypsum" says Dave.

The growth of a petrochemical industries complex around the refinery will increase the level of pollution in the area. Another consideration in future is the possible expansion of the six million tonnes capacity to 10 million tonnes as envisaged by the project report.

. Lovers may simply have to look for another symbol of undying love.

Table 3. Selected atmospheric pollutants

POLLUTANT	PRINCIPAL HUMAN SOURCES	EFFECTS	REMARKS
CARBON DIOXIDE	Fuel combustion for heating, transport, energy production.	No direct effect on people. Over time, may lead to increase in earth's temperature.	Normal constituent of atmosphere. Essential to plant life.
CARBON MONOXIDE	Incomplete fuel combustion (as in motor vehicles).	Deprives tissues of oxygen. People with cardio-respiratory diseases more sensitive.	Contribution of natural sources small. Smoking more significant for humans than exposure to traffic.
SULPHUR DIOXIDE	Burning of sulphur-containing fuels like coal and oil.	Combined with smoke, increases risk and effects of respiratory diseases. Causes suffocation, irritation of throat and eyes. Combines with atmospheric water vapour to produce acid rain. Reduces crop yields. Leads to acidification of lakes and soils. Corrodes buildings.	
SUSPENDED PARTICULATE MATTER	Smoke from domestic, industrial and vehicular sources.	Possible toxic effects depend on specific composition. Aggravates effects of sulphur dioxide. Reduces sunlight and visibility. Increases corrosion.	Chemically, a most diverse group of substances. Natural sources include dust-storms, volcanic eruptions and sea spray.
OXIDES OF NITROGEN	Fuel combustion in motor vehicles and furnaces. Forest fires.	Possible increase in acute respiratory infections and bronchitis morbidity in children. Produces brown haze in city air. Causes corrosion.	Nitrogen oxide and nitrogen dioxide are the two components.
VOLATILE HYDROCARBONS	Partial combustion of carbonaceous fuels, industrial processes, disposal of solid wastes.	React with other pollutants to produce eye irritants (acrolein, aldehydes). Ethylene is harmful to plants. Aerosol particles reduce visibility. May produce unpleasant odours.	
OXIDANTS AND OZONE	Emissions from motor vehicles. Photo-chemical reactions of nitrogen oxides and reactive hydrocarbons.	Cause eye irritation and impaired pulmonary function in diseased persons. Corrode materials and reduce visibility. Ozone is one of the most damaging pollutants for plants.	Mainly derivative: products of atmospheric reactions between other pollutants. Ozone is a natural and essential constituent of the upper atmosphere.

Source: Preparatory document 48/8, Conference on the Human Environment, Stockholm 1972.

Fertiliser factories

There are 67 large fertiliser factories in India. Fertiliser production in the country has increased from a mere 27,000 tonnes in 1950-51 to three million in 1979-80.

Fertiliser plants generate large quantities of air pollutants, some of which can be valuable by-products. The main effluents are fluorine gas, particulates, sulphur dioxide and trioxide from sulphuric or phosphatic acid units and nitrogen oxides, ammonia, hydrocarbons and particulates from nitrogen-based plants.

Compared to the cost of a fertiliser plant, pollution control equipment costs are small. Dr V. Pachaiyapan, director of the Fertiliser Association of India, gave a figure of Rs 76 lakhs at the "Air Pollution '82" conference in New Delhi. In most plants, however, adequate pollution control systems have not been incorporated in the original designs.

A serious risk situation has arisen at the fertiliser factory in Avadi, Tamil Nadu, writes "The Hindu." Pollution became acute when the stack of the factory collapsed. Fumes were let off at levels far below the original 10.5 metres height. Breathing difficulties and irritation of the eyes among patients were reported by medical practitioners. Grills, gates and utensils in homes have been corroded by sulphur fumes.

Textile mills

Textile mills operate in humid environments and handle a variety of organic chemicals in large amounts. Their major effluents are cotton dust, smoke and other combustion wastes, kerosene or naptha vapours, sulphuric acid, nitrogen oxides, chlorine, formaldehyde and chlorine dioxide. G.R. Pillai and S.M. Doshi of the Bombay Textile Research Association (BTRA), an industry supported organisation, admit: "The ill effects of all such pollutants have not been fully realised in India with the result that control measures are seldom as rigorous or persuasive as in foreign countries".

Areas around textile mills are usually covered with a thin deposit of cotton fluff or dust. Workers inside the mills and residents outside have little choice but to inhale it. Continuous inhalation causes byssinosis, weakens respiratory functions and resistance to lung diseases, especially TB and chronic bronchitis. A survey conducted by Bombay's KEM Hospital reveals 10 to 16 per cent incidence of byssinosis among textile mill labourers.

An average textile processing unit in India vents about 50,000 to 125,000 litres of kerosene or naptha vapours, worth Rs 1-2.5 lakhs at market prices, according to BTRA scientists. Spurred by the incentive of financial savings, the BTRA has developed a kerosene recovery unit as also a kerosene substitution process.

Traffic

There are 3.7 million motor vehicles on the roads of India, according to the National Transport Policy document (1980). They include 0.84 million cars and jeeps, 0.44 million trucks, 0.24 million buses and 83,000 taxis. The exhaust fumes they emit contain carbon monoxide, nitrogen oxides, hydrocarbons, aldehydes and lead oxides. The black smoke emitted by diesel engines contains more particulates than the exhaust of petrol engines though other pollutants like carbon monoxide, hydrocarbons and aldehydes are less.

Traffic pollution is significant mainly in congested, poorly ventilated streets. According to Prof J.N. Dave, Dean of the School of Environmental Sciences at the Jawaharlal Nehru University, automobile emissions in Bombay and Delhi account for 70 per cent of carbon monoxide, 50 per cent of hydrocarbons and 30 to 40 per cent of particulates in the atmosphere.

Motor vehicles are the main source of carbon monoxide in Indian cities. The gas decreases the capacity of the blood to carry oxygen from the lungs to the tissues. Constant or prolonged inhalation of carbon monoxide in dense traffic areas poses a serious risk to people with cardiovascular problems. The amount of carbon monoxide absorbed by such people, however, is much less than that absorbed by people smoking a few cigarettes in the open country.

A short term survey by the National Institute of Occupational Health, Ahmedabad, indicated that lead concentrations in the blood and urine of policemen and roadside shopkeepers was significantly higher than that of the unexposed community.

Photochemical reactions involving hydrocarbons and nitrogen oxides create smog (smoke + fog). It requires the presence of sunlight and a stagnant or slow moving air mass. Smog reduces visibility in the sky and irritates the eyes. In recent years smog has become an increasingly frequent menace in New Delhi.

The best remedy against noxious automobile emissions is a well-maintained engine. In India most cars are old and poorly maintained. A dated CPHERI report (1970) estimated that new cars in India emit about six per cent carbon monoxide in the exhaust, as against the upper limit of two per cent in the U.S. Catalytic converters, which are extensively used abroad, require lead-free gasoline which is generally not available in India.

Stringent emission standards have been successfully imposed on car manufacturers and owners in North America. Mandatory emission standards have neither been consi-

Like a number of rapiers, the chimneys of textile mills stab the sky above Ahmedabad, reducing its air quality to about the worst in the country. (Indian Express)/Shanti Shah)

dered nor set anywhere in India. This is an indicator of the seriousness with which the authorities view the problem of traffic pollution.

Domestic

Air pollution reminds most people of fall chimneys at factories belching out thick clouds of black smoke. The fact that old people, women and children face far more serious risks due to pollution from smoke inside their homes is not even generally known. Women squat in front of their stoves, a few hours a day, to prepare the family's meals. Children have a higher breathing rate, they are more active and short in height. These factors increase their susceptibility to respiratory ailments. The homes of poor people are in general not even well-ventilated.

A Government of India document prepared for the United Nations Conference on the Human Environment in 1972 admitted, that "The present total emission of carbon monoxide, sulphur dioxide, nitrogen oxide, organics, particulates, etc, are much larger (as compared to other sources) from burning of firewood, cattle dung, vegetable waste products, refuse, etc". This is because half of all the energy consumed in India is for cooking purposes and over 90 per cent is from the so-called non-commercial fuel sources. (See chapter on Energy).

A detailed scientific study of this problem is urgently needed. Projections of the working group on energy policy of the Planning Commission indicate an increasing use, in absolute terms, of the non-commerical fuel sources in the next two decades. The problem will, thus, only get worse unless smokeless chulhas can be promoted on a massive scale.

The noise nuisance

Noise is not only a nuisance; it is a health hazard. Indians — who have the dubious distinction of being amongst the noisiest people in the world — are deaf to this fact.

Addressing the Indian Science Congress' annual convention in January 1981, its President, Prof A.K. Sharma, said, "In the absence of any preventive measures, Indian towns are noisier than those in the West. Calcutta, Bombay and Delhi are regarded to be among the noisiest cities in the world, where the average noise level even 10 years back was 90 decibels." (Decibel is a unit of noise on a logarithmic scale.)

In addition to factories, automobiles, trains and aeroplanes, religious and social ceremonies are also a noise nuisance. "Perhaps the most important source of noise of immediate concern in our country, is that associated with the social and religious ecstasies patterned by us," notes a study made by SOCLEEN. A noise level survey by SOCLEEN in the most crowded localities of Bombay during the Ganpati festival in 1980, found levels upto 97 decibels. The noise level at airports measures about 90 decibles.

Loudspeakers are a big way of expressing ritual fervour in India. Births, marriages, deaths, all appear to be apt occasions for their use. "Loudspeaker wars" between temples and mosques are known to have sparked communal riots.

Prolonged exposure to noise levels above 90 decibels can cause permanent deafness — factory workers show neurological, digestive and metabolical disorders under such conditions. Researchers claim that if present noise levels continue unchecked, future generations may be born deaf.

In the West, noise pollution is checked by legislation. In India, we do not have any law regarding noise levels. Says Dr V.D. Kulsreshtha of the Indian Law Institute at New Delhi: "A separate legislation in India to control noise sources is extremely significant and timely." But no amount of legislation will help, unless we are convinced that noise is a menace and take steps to curb it.

Smoke, a health hazard, is the hidden cost of cooking in most Indian homes. (Earthscan/Mark Edwards)

STATE OF THE CITIES

While the large metropolitan cities suffer the worst levels of air pollution in scale, smaller towns are catching up fast. Indeed, with crowded streets, poor industrial zoning and almost total absence of curbs on emissions, they are in many ways worse off. But there is no quantitative data available for such areas.

The NEERI report, from which data is summarised in Table 2, barely covers 10 cities. It gives the results of a two-year monitoring programme (shorter periods in the case of some cities) from 1978-79. This report, however, leaves a lot to be desired. For example, Bangalore, the fifth largest city in the country, is not included in its air monitoring network. It makes no reference to the earlier study conducted by its predecessor, CPHERI, in 1970. Necessary corroborative information which can be used to assess anomalies in the data for 1978 and 1979 is not given.

With one exception, the data indicates a sharp increase in sulphur dioxide levels in all cities. In the case of Delhi, there is apparently a slight fall. In the absence of experimental details, this inconsistency can only be speculated upon. Prof Dave of Jawaharlal Nehru University has argued that domestic fuel consumption accounts for over half of Delhi's air pollution load. If anything, Delhi's sulphur dioxide levels, given increased industrial activity, should have risen appreciably between 1970 and 1978. In 1978, Bombay, Calcutta and Ahmedabad exceeded the ISI (Indian Standards Institution) standard of 60 ug/m^3 (micrograms per cubic metre).

The Suspended Particulate Matter (SPM) counts are much above the comparative figures cited in the report's appendix for vaious cities in Europe and North America, ranging from 60-150 ug/m^3. SPM is a complicated entity, but its major component is particles produced by burning fuels. In other words, smoke levels in Indian cities are very high.

Dust levels in India are also high, being a tropical country. It is all the more necessary, therefore, to control the amounts of pollutants generated by human activities.

Bombay

Of the four metropolitan cities, Bombay's predicament is probably the worst if only because of the city's peculiar geography: a number of heavy industries are crowded, cheek by jowl, on the eastern coast of the island, overlooking the mainland across Thane creek. The main offenders of air pollution standards are the Rashtriya Chemicals and Fertilisers (RCF), the Bharat Refineries and Hindustan Petroleum refineries, the Tata thermal power plant and the Bombay Gas Company, and scores of petrochemical plants which followed in the wake of the refineries a couple of decades ago.

All these big units, with the exception of the gas company, are located in the Trombay-Chembur area. The 100-year-old Bombay Gas Company is situated in Lalbaug. Also in the Lalbaug-Parel belt are most of Bombay's textile mills whose tall chimneys spew tonnes of pollutants into the atmosphere every day. To make matters worse, the RCF plant and the refineries are about to expand or are already in the process of doing so; Tatas have already put in a massive 500 MW unit and have applied for yet another of the same capacity.

Table 4. Pollutants in Greater Bombay (percentage)

Source	Sulphur dioxide	Particulate matter	Nitrogen oxide	Carbon monoxide	Hydrocarbons
Domestic	0.8	20.0	3.6	2.0	2.4
Commercial & institutional	0.6	2.8	1.1	-	-
Industrial	68.8	15.0	36.4	29.0	51.4
Power generation	18.0	30.0	30.6	0.5	-
Transport	11.8	32.0	28.0	68.5	46.2

Source: Scavenger, April 1980 (monthly journal of SOCLEEN)

The most indefatigable environmental activists in Bombay belong to the Society for Clean Environment, more commonly known by its acronym, SOCLEEN. They list 417 major industries in the city. Unlike other Indian cities, where a large fraction of the pollutants are generated in the home, in Bombay, transport and industrial activities contribute far more to the air pollution in the city (see Table 4).

Ironically, the pollutants emitted by these industries affect citizens living in the eastern suburbs and then waft across the creek, since the winds, particularly during the monsoon, are from the south-west. This makes the so-called twin city of New Bombay the unwilling beneficiary of Bombay's waste and toxic gases. The National Environmental Engineering and Research Institute (NEERI), which conducted surveys of New Bombay's pollution levels in the early '70s found that the sulphur dioxide levels there were 108 ug/m^3, as against only 61 ug/m^3 for metropolitan Bombay.

The impact of this pollution is evident from a detailed study of 4000 people conducted by Dr R.S. Kamat of Bombay's KEM hospital and the Air Pollution Prevention Cell of the Bombay Municipal Corporation in 1977-78. The health of residents in a clean, western suburb like Khar was compared with that of residents of Chembur and Lalbaug. The survey revealed that people living in the congested industrial areas suffered from a much higher incidence of diseases like chronic bronchitis, TB, skin allergy, anaemia and irritation of the eyes. The absentee rate of workers was much higher, particularly in Lalbaug's textile mills. What is more, there was a rise in the number of deaths due to cancer in Lalbaug — twice as many as in Chembur or Khar.

The high pollution levels in Bombay are all the more serious considering that parts of the city have among the highest densities of population in the world. One of the earliest environmental bodies formed to fight this menace was the Save Bombay Committee, though the contribution of SOCLEEN has been far more substantial. Consisting largely of scientists from the Bhabha Atomic Research Centre, which is based in Trombay, SOCLEEN has built up a large data base on pollution and, among other things it, has effectively countered the claims made by RCF regarding its emissions. The Bombay Environmental Action Group (BEAG) was ostensibly meant to be an umbrella organisation for groups like the Friends of Trees, Bombay Civic Trust and so on but was primarily formed to fight the location of the Thal-Vaishet fertiliser plant and since then, has directed its fire against the Oil and Natural Gas Commission's base at Nhava island.

The Bombay Municipal Corportion (BMC) is closely

analysing air quality in metropolitan Bombay through a network of about 20 stations. The RCF factory in Chembur is also monitoring air samples with a well-equipped mobile facility. At a national conference in Delhi, V.B. Shirodkar of the BMC's Air Pollution Cell claimed that effective pollution control measures had already reduced sulphur dioxide contamination in Chembur by half.

Delhi

After Bombay, Delhi's air pollution problems have attracted the most attention apparently because the nation's lawmakers and bureaucrats reside there.

The two biggest air polluters in Delhi are the Badarpur and the Indraprastha (IP) thermal power stations. Together they emit 180 tonnes of fly ash and 70 tonnes of sulphur dioxide every day. Thick black smoke from the IP station's chimneys coats the surroundings with a layer of soot. Three of its five units have EPs that are 14 to 15 years old, according to a report in "The Times of India", and their operating efficiencies have dropped to 80 per cent from the 99 per cent rated value.

For years Delhi's citizens have suffered the risk of respiratory diseases and few of their powerful neighbours have done anything about it. In the vicinity of the IP station are the offices of the World Health Organisation, the Indian Medical Association, the Indian National Science Academy, the Indian Standards Institution, the Supreme Court and the School of Town Planning and Architecture, all having some interest in the environment.

Now orders have arrived to clean up the air in time to receive the visitors to the Asian Games, according to a report in "The Times of India". One of the five units at Indraprastha has been fitted with an EP at a cost of Rs 1.46 crores and a second one will be installed costing Rs 2.8 crores. Many Delhi citizens joke that the precipitators will work only for the duration of the games.

Prof Dave estimates that domestic fuel burning generates about half the air pollution load in Delhi. "When humidity is high, this also results in the formation of smog, which is a commonfeature of Delhi's environment." To add to the capital's woes, heavy dust storms occur in summer. NEERI has recorded dust levels as high as 2000 ug/m^3 there.

Madras

Madras is a little better off. Its major industries include the Madras Refineries Ltd (MRL), Madras Fertilizers Ltd (MFL), Kothari Chemicals and Thermal Power Stations at Ennore and Basin Bridge, among others.

Sulphur dioxide contamination is a major problem in certain areas. MRL processes crude oil with a high sulphur content and the thermal power stations at Ennore use coal with a high sulphur content. The MFL unit vents urea dust into the atmosphere. Large amounts of ammonia are said to leak out from pipelines and storage tanks, causing irritation to the eyes and coughing.

Fly ash produced by burning the coal is mixed with water and dumped off the coast, via a pipeline, at Ennore. The fly ash is suspected to contain heavy metals which are likely to accumulate in the tissues of fish in that area, a major fishing ground.

Outside Bangalore is Graphite India's multicrore industrial unit. It spews out fine graphite dust day and night. The dust settle on open surfaces, "killing plants, flowers and leaves; enters the human body, causing unpleasantness, lack of appetite, irritation in the eyes and stomachaches and affects people living in villages nearby," reports the "Deccan Herald." A TB sanatorium is located nearby. Repeated requests by neighbouring factories to control emissions have fallen on deaf ears. One unit located behind Graphite India provides its workers with eye drops to soothe irritated eyes.

Calcutta

Calcutta, according to Dr B.B. Sundaresan of NEERI, emits a total of 1299 tonnes of pollutants a day. This works out as shown in Table.4

"In addition to industrial and power generation sources," says Sundaresan, "domestic burning of low grade coal releases a considerable amount of sulphur dioxide in the region". A NEERI report says that 60 per cent of Calcutta's residents suffer from respiratory diseases because of the air pollution. The effect of such pollution on a person is equivalent to that of smoking 20 cigarettes a day.

Table 5. Total emission of pollutants in Calcutta

Source	Amount (tonnes per day)	% of total
Suspended particulate matter	557	43
Sulphur dioxide	122	9
Carbon monoxide	448	35
Hydrocarbons	102	8
Oxides of nitrogen	70	7
Total :	1,299	100

Source : NEERI, Nagpur

Even in the best planned city in the country, Chandigarh, the annual geometric mean of dust levels is considerably higher than the American standard of 80 ug/m^3, which is why SOCLEEN argues that given metereological conditions in India, it will be more realistic to adhere to European standards of 150 ug/m^3. Significantly, while the highest dust levels in Chandigarh are recorded in summer, January levels are also appreciable (121 ug/m^3). The Government Hospital in Chandigarh documented a high incidence of throat and respiratory diseases among the population.

The environmental impact of big complexes like Korba in Madhya Pradesh are seldom studied well, only the emissions of individual plants are accounted for. Yet the total damage done by units in Korba, which include the giant thermal power stations, aluminium and fertiliser plants, is awesome. Proper monitoring is also called for at petrochemical complexes like that at Baroda. The consequences of such development ought to be considered at the planning stage itself. Another little-studied phenomenon is the impact of a cement factory—like that near Bilaspur in Madhya Pradesh—which sheds its dust on the surrounding fields and plants, badly damaging the crop.

A word of caution is necessary about describing any city

Clean air is a rare phenomenon in large Indian cities. In contrast to cities in the industrialized nations, the major source of pollution here is the burning of non-commercial fuels in homes. (SPAN/Avinash Pasricha)

as "the worst polluted in the country". In January this year, Mr. C.P.N. Singh, Union Minister for Science, Technology and Environment, announced in the Lok Sabha that Ahmedabad is the "worst polluted" city in the nation. His evidence: its sulphur dioxide levels were higher than that of any other Indian city. Such a characterisation is fallacious. It must take into account the variety of pollutants, the sites of their release, the population density, etc.

Fortunately, in the big cities and towns, there are pressure groups and officials to whom protests can be made. In villages like Garudacharpalay, Maruthahalli or Nekkundi near Bangalore, which have the polluting Graphite India as neighbours, community organisation for effective protest takes a long time to emerge. Meanwhile lungs, fruits and buds continue to wither away.

POLLUTION CONTROL LAW

Recognising the growing menace of air pollution in the country, the Central Government enacted the Air (Prevention and Control of Pollution) Act in 1981. In fact, it took about 10 years to come. An expert committee had prepared a draft bill as long ago as 1972.

Significant features of the new law are that it provides for the necessary administrative structures at the federal, state and local levels with some powers to implement the law; it lays down methods of promulgation and implementation of regulations, monitoring procedures and their mechanism; it provides for the promulgation of air pollution control actions through which standards can be prescribed for emissions for old and new sources. A number of other features are similar to the Water Pollution Control Act, passed in 1974.

The difference between the two pieces of legislation is that air pollution control is a Central Act based on the preamble of the Constitution and, therefore, all States are compelled to set up boards. The Water Pollution Control Act on the other hand, was enacted under Article 252 of the Constitution and States were left to form boards voluntarily. Thus, the six States, including Tamil Nadu, Orissa, Mizoram and Nagaland, which have not yet set up water pollution control boards will have to set up air pollution control boards. Besides, these boards will levy fees for granting consent to industries and this will provide a measure of financial support.

There are, however, many lacunae in the Act. For instance, Dave points out that it does not provide for coordination between air quality and other environmental statutes like water pollution control and urban planning. Furthermore, "there is no provision for exercising control over industrial location, which should become a primary tool in pollution control. The board's consent is to be sought only after the finalisation of the site, which gives it little scope to influence proper selection." Neither has any procedure been laid down for preparing environmental impact assessments from the air pollution angle for new consent grants.

Dr Ramanathan of the Department of Environment (DOE) believes that it is better to adopt the American practice of making a polluter pay damages or compensation depending on the amount of damage caused, rather than restricting the amount by law. The Act only provides for a three-month jail term and/or a fine of Rs 10,000 which may be extended by Rs 100 a day for continuing infringement of the law. This means that a huge chemical or engineering company pays the same penalty as a small concern. Failure to comply with the provisions of the Act within a year of conviction can lead to six months imprisonment.

Dave warns that no control will be exercised over the type of fuel to be burnt in air pollution control areas, so that the atmosphere will not be cleansed by legislation. The Act does not lay down specific criteria for control of emissions from motor vehicles.

The polluted and the dying

People of Nalavagulu village of Chitradurga district in Karnataka face a Hobson's choice: either they can cling to their ancestral village, whose air and water are being poisoned by the effluents of a chemical factory, and die a painful slow death or look for a new place to settle. They have nowhere to go, however, and nobody is in a hurry to save them.

The culprit of this environmental disaster is Harihar Polyfibres — a Rs 25 crore Birla company which was established in 1969. What was once seen as a boon by the villagers, providing many jobs, has turned into a virtual nightmare.

The fortnightly "India Today" reports that as production began, Harihar Polyfibres' tall chimneys started "showering soot mingled with chemicals and other toxic by-products". Now "pillars supporting huts, beams holding the roofs of houses almost crumble into powder at the barest touch." A brass pitcher presented by Harihar Polyfibres to the Nalavagulu school two years earlier crumbled when the magazine's photographer tried to lift it.

The variety of diseases reportedly afflicting men, women and children include "skin eruptions, boils, pockmarks as in smallpox, dry skin and skin irritation, cracked soles, burning sensation accompained by cough, yellowing of the eyes as in jaundice and an unknown malady of the intestines". Livestock and other animals were also noticeably suffering from unusual ailments.

Water tanks near the factory are covered with a stream of froth. "The froth bubbles keep on popping about and their spray settles down on human eye, ear, nose, besides contaminating exposed food."

Treated effluent waste is dumped in the Tungbhadra river through an open drain. "We have put up a Rs 1.2 crore treatment system and are spending Rs 30,000 a day to treat the water discharged," said K.I. Philip, Chief Executive of the Plant, in an interivew. "Why should we spend another Rs 25 lakhs for covered drainage pipes?"

According to Philip, after the installation of a Rs 3.2 crore electrostatic precipitator, "the air the Nalavaguluans breathe is as pure as mountain air". Yet, India Today's correspondents reported, "Less than 24 hours exposure to the Nalavagulu atmosphere was enough to make us itchy and our eyes watery."

The Nalavagulu residents are desperate. All they want anew is 40 acres of land elsewhere with dwellings. But who will provide it?

According to a senior government official the effectiveness of the Act will be impaired by the lack of monitoring and follow-up equipment and personnel. "Boards should not do the monitoring of ambient air levels," he warns, "because they will get bogged down in what is essentially a routine function."

The same has already happened to water pollution control boards. With the exception of a couple of them — notably in Gujarat — most continue to be poorly staffed and inadequately funded.

According to one estimate, the new air pollution control boards will immediately require the services of 1200 to 1400 technically trained personnel, while at least twice as many will be needed by industries and private consultancy firms. "These initial difficulties are inevitable," says Dilip Biswas from the Department of Environment. "Legislation will help create the demand for manpower, laboratory facilities and monitoring and control equipment. If legislation had been held back because of present non-availability of infrastructure, it would never have had the chance to develop."

A lot of hot air

The trouble with the Air Pollution Control Act is that, like the earlier Water Pollution Control Act, it may accomplish just what Biswas of DOE predicts — develop an infrastructure, or in other words, create a bureaucracy. And it may generate a lot of hot air as evident from the rash of seminars held around the nation after the enactment of the law.

Despite some interest shown by representatives of Indian industry at the seminars, the boardroom attitude remains unpromising in curbing air pollution. This attitude is best summed up in the words of a senior executive of Graphite India. "Pollution is the price society must pay if it wants modern industry to thrive ..... if we close down, society will have to pay a higher price (than mere pollution)."

This kind of knee-jerk demagoguery was indulged in by the captains of industry in developed nations when legislations were first enacted there to clean the air and curb further pollution. Thanks to strict controls on emissions of industry, power generating stations and automobiles, air pollution levels have now declined in New York, London, Paris and Tokyo among other cities of the industrialised nations.

India's uncontrolled industries and badly maintained automobiles may be far fewer in number, but they rival all those in the West in their pollution generating capacity. To prevent the air pollution levels in Indian cities from getting worse, a few basic steps will have to be implemented first. The hazards of domestic pollution can be reduced by popularising the use of efficient stoves. Exhaust emission control standards for motor vehicles need to be set and enforced. Traffic in congested or ill-ventilated streets must be limited. Air Pollution Control Boards will have to survey the air quality immediately. Once emission standards are established, citizens' panels should be constituted to review compliance. Violations should be penalised, according to the extent of the assessed damage.

To do this requires political will and a genuine concern for the quality of the human environment. So far, these qualities have been largely absent in our administrators.

Plants and air pollution

Delivering the presidential address at the annual convention of the Indian Science Congress held at Banaras Hindu University in January 1981, Prof A.K. Sharma said that plants have been found to be seriously affected by air pollution. Mango trees in Bombay have been damaged due to air pollution, according to a three year study, titled "Effects of Industrial pollution on Plants" conducted by Dr S.B. Chaphekar and his colleagues at the Institute of Science, Bombay.

This study shows that mango trees along road sides were damaged considerably; up to 30 per cent of the tree-leaves were rendered dead. In areas surrounding the Hindustan Petroleum Refinery, some trees were completely ruined.

Plants show reduced photosynthesis in the presence of pollutants. Hence the air-purifying action of plants — absorbing carbon dioxide and releasing oxygen — is reduced, resulting in a vicious circle of increased pollution. A recent West German study, quoted by the National Geographic magazine, has linked acid depositions due to acid rains with the decline in forest growth. Air pollution is known to affect crops too. Researchers in Japan have linked decline in rice production with increase in atmospheric levels of sulphur dioxide.

Interestingly, the extent of damage to plants can serve as an index of ambient air pollution. According to Dr Chaphekar, "When vegetation is injured by air pollution, symptoms characteristic of the specific pollutant usually develop. Since the pollutant itself undergoes a chemical change after it contacts the plant tissues, these symptoms are often only remaining evidence of the pollutant's assault. Thus the type of injury on a sensitive plant species provides a fairly accurate means of monitoring pollutant emission." In the absence of more sophisticated equipment — which only a few scientists have access to anyway — such methods do provide a rough and ready index of contamination.

The Thal-Vaishet controversy

While the Thal-Vaishet fertiliser plant near Bombay was international news because of the World Bank's withdrawal of its $ 250 million loan following a change in consultants, the plant was earlier confronted with a fierce environmental controversy over its location. When built, it will be the largest urea producing unit in the world.

Despite pleas from environmentalists that Thal was only about 20 km from Bombay — across the creek on the mainland — and fell within the region under the Bombay Metropolitan Regional Development Authority (BMRDA), the Maharashtra Government and the public sector Rashtriya Chemicals and Fertilisers Ltd (RCF) were able to steamroll their way through.

The first choice for the massive plant, which comprises two units producing 2700 tonnes of ammonia a day and three producing 4500 tonnes of urea, was a site named Mandwa-Rewas, directly across the Bombay harbour and only 12 km from the metropolis. Press reports first mentioned this fact in August 1977. Conflicting statements were issued by the Central and State Government about it. The former, for instance, claimed the complex would occupy 3000 acres, while the latter put the area at only 500 acres, which would mean displacing just 260 families.

The Bombay Bachao Committee was formed as an umbrella organisation for others like the Save Bombay Committee, Bombay Civic Trust, Society for Clean Environment (SOCLEEN) and Friends of the Trees, to fight the location of the RCF plant. As the controversy grew, it became apparent that the Centre's estimate was more accurate and local residents, including many fisherfolk, formed the "14 Villages Shetkari Bachao Andolan Samiti" to oppose the take over of their land.

Faced with these two sources of opposition — from the villagers and environmentalists in the city — the Centre decided to refer the issue to the then National Committee on Environmental Planning and Coordination (NCEPC, now just NCEP). In April 1978, the NCEPC task force, headed by Dr A.K. Ganguly, director of the chemical group of Bhabha Atomic Research Centre, submitted its report and rejected Mandwa-Rewas as a site for the factory. While it conceded that it had certain "techno-economic advantages" being closer to the source of feedstock — natural gas from Bombay High — the resultant air pollution would pose a danger to the 70,000 inhabitants of Alibag town, just 10 km from the site. Even more significantly, it reported that a "natural ecological balance exists in the profusely vegetated Alibag area . . . the community residing in Mandwa is self–sustaining and economically viable."

The report, however, did make it clear that the Bombay Bachao activists were barking up the wrong tree when they claimed that fumes from the giant fertiliser plant would engulf Bombay and plague its citizens. On the contrary, the predominantly south-westerly winds would carry pollutants from the eastern coast of the peninsula of Bombay to the site of the new plant, not the other way round.

The task force instead recommended Tarapur, also on the coast, but further north in Maharashtra, because it is sparsely populated and the surrounding land is not as fertile as that around Mandwa. Besides, a vast stretch of land is available for disposal of effluents, unlike in Mandwa where these would have to be dumped into the sea near the Thane creek, taking a heavy toll of the fish consumed by thousands of Bombay's citizens.

The Central Government, headed by Prime Minister Morarji Desai, decided to locate the plant at Tarapur. But the Maharashtra Government headed by Sharad Pawar, was anxious not to lose the petrochemical units associated with the fertiliser plant to nearby Gujarat. These units would attract some Rs 1000 crores worth of investment — twice as much as the fertiliser plant was estimated to cost by the Lavraj Kumar committee in 1977 — and employ many more people than the 1500 directly needed at the plant. The Maharashtra Government feared that if the fertiliser plant was located at Tarapur, the downstream units may spill over into Gujarat, especially since the Indian Petrochemicals Ltd, one of the biggest complexes of its kind in Asia, is already located in Baroda.

As a result of pressure from the Maharashtra Government, New Delhi asked the NCEPC to study some more sites: five locations were selected by the State authorities and were all in Alibag taluka of Kulaba district. In May 1978, the Ganguly team again plumped for Tarapur and ruled that "from the environmental point of view, Thal-Vaishet is even less suitable than Mandwa — Rewas." Even so, the Maharashtra Chief Minister misrepresented the NCEPC's findings to MLAs in the assembly — to this day, these reports have not been made public — and said that the committee had agreed to Thal, which was just five km from Alibag and 10 km from Mandwa-Rewas. When the Bombay Bachao Committee met the Prime Minister to register its protest, he stated that the decision now lay with the Maharashtra Government, with no pre-condition — technical or otherwise — except that the Centre would not be responsible for compensation or damages if the site remained at Thal.

Although Sharad Pawar was apprised of these discussions and appeared to be agreeable to considering Usar — which was one of the five sites studied the second time, but was outside the Bombay metropolitan area — nothing came of it. By November 1978, RCF proceeded to acquire land for the project. Despite some delay because of the World Bank's withdrawal of aid towards the end of 1980, other funders have been found and work on the site is proceeding full steam.

The strong protests have forced the RCF to be more sensitive to environmental concerns. A battery of pollution measures are to be taken, including increasing the chimney height from 90 metres to 150 metres; using high quality coal with low ash content; using natural gas from Bombay High with no sulphur in it; installing giant EPs, and continuously monitoring the pollution levels at three stations around the plant.

These measures will cost about Rs 30 crores out of a total outlay of Rs 950 crores (up from around Rs 500 crores, the original 1977 estimate).

While the Central Government has recently given permission to the Oil and Natural Gas Commission to build an oil refinery at the nearby Nhava island, the location of the petrochemical complex remains unresolved. The second report of the NCEPC categorically stated that no such complex or ancillary industries should come up at any of the five sites it studied. An oil refinery at Nhava could be used as a justification to locate the petrochemical complex in the vicinity. This would be an environmentally backward step for the region.

CLIMATE AND CARBON DIOXIDE

The possibility of a global climatic change taking place by the end of the century because of increasing carbon dioxide in the atmosphere has become a subject of considerable discussion amongst scientists in recent years.

Several international organisations like the World Meteorological Organisation, United Nations Environment Programme and the International Council of Scientific Unions and national research organisations in the US, Europe and USSR are conducting extensive research programmes on the subject and have organised several conferences and seminars on it in recent years.

Observations at the Mauna Loa Observatory in Hawaii show that carbon dioxide levels have been steadily rising at 1 ppm (part per million) per year — from 311 ppm in 1957 to 338 ppm now.

Scientists are now fully agreed that this increase in carbon dioxide levels in the atmosphere will mean a steadily warmer earth. Exactly what will be the effect of this warming on various countries is still a matter of considerable scientific controversy but the scenarios that are being painted by many scientists are cause for considerable apprehension.

The developing world, unfortunately, has been so engrossed in the "present" that this rather futuristic problem has not yet attracted wide attention. But a global climatic change can indeed seriously affect developing countries like India too. It is, therefore, important to study what those effects are likely to be and for the public to be aware of the dangers confronting it. It is quite possible, for instance, that agriculture as practised for centuries in India may have to change and crop outputs may become a matter of even greater uncertainty than today.

The obvious question is: why is the carbon dioxide concentration in the atmosphere increasing?

The earth has a finite and definite amount of each element which does not change in normal circumstances. While a part of this total quantity may exist as a free element,the remaining part usually exists as compounds locked in with other elements. The absolute amount of carbon on the earth is also constant.

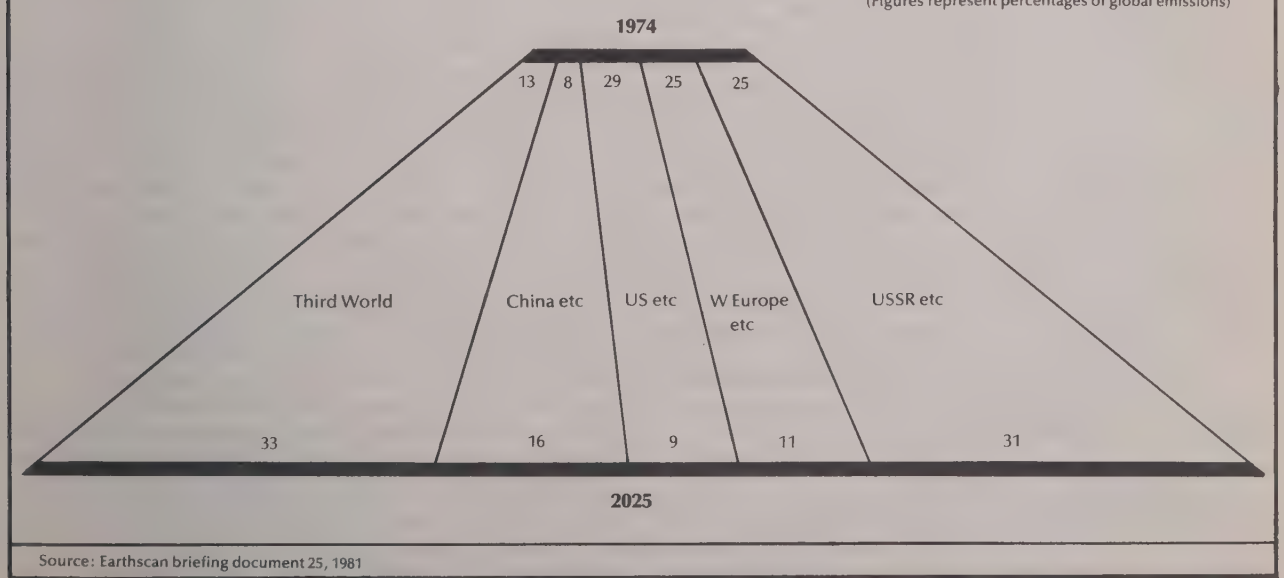
An enormous amount of carbon exists underground in the form of hydrocarbons (coal, oil and natural gas) and as carbon compounds such as carbonates. A large amount of carbon is present in the oceans as carbon dioxide dissolved in water and as carbonates. The atmosphere also contains large quantities of carbon as carbon dioxide. Finally, living organisms, from microbes to plants, animals and human beings, account for another major fraction of the earth's carbon.

If the carbon which is buried as coal, oil and natural gas were to remain untouched, then the remaining carbon in the atmosphere, the oceans and the biota (the totality of living organisms), would constitute a natural cycle which would in normal circumstances maintain a balance. For instance, the carbon dioxide released to the atmosphere through transpiration returns to the biota through the photosynthesis of plants.

As plants use large quantities of atmospheric carbon dioxide in photosynthesis, a series of major earthquakes which buried vast areas of vegetative cover underground, could theoretically reduce the atmospheric fraction of carbon dioxide. This is probably what actually happened millions of years ago and created our current reserves of underground carbon products like oil, coal and natural gas. All these hydrocarbons remained buried until the age of industrialisation began. Before this period, people burnt

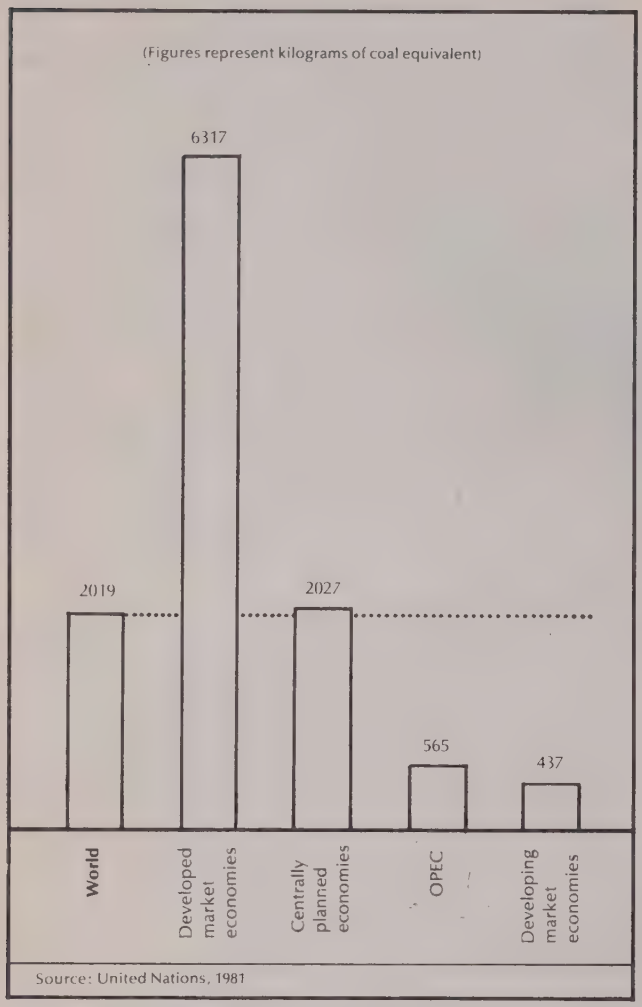
Figure 1. Carbon dioxide emissions: 1974 and 2025

By 2025, global carbon dioxide emissions will be six times what they were in 1974. The Third World, which is likely to rely heavily on coal, will be putting out a far higher share than it does today.



Source: Earthscan briefing document 25, 1981

Figure 2. Per capita consumption of commercial energy in 1979.



wood to meet their energy needs but extensive deforestation did not take place because there were fewer people on the earth. Now the escalation in living standards, together with the accelerated pace of industrialisation, has greatly increased the demand for hydrocarbons. Thus a large amount of carbon, which was earlier buried in the earth, is now being brought into the atmosphere leading to a net increase. It is estimated that for each tonne of coal mined and used, 0.693 tonnes of carbon are pumped into the atmosphere as carbon dioxide; for each tonne of crude petroleum produced, 0.769 tonnes of carbon; and, for each million cubic metres of natural gas produced, 524 tonnes of carbon.

In other words, it is largely or wholly human activity that is responsible for this increase in the concentration of carbon dioxide in the atmosphere.

Poor records

Records of carbon dioxide concentration in the atmosphere in the past are poor. Most chemistry and plant physiology text books written in the last century mention a concentration of about 270 to 295 ppm. Today it is about 338 ppm, up about 15 to 20 per cent from pre-industrial levels.

Regular monitoring of carbon dioxide concentration began in 1957 at the Mauna Loa observatory in Hawaii. Today there are about 50 stations distributed over both the hemispheres regularly monitoring carbon dioxide concentration. Future projections show that the carbon dioxide concentration in the atmosphere should double by 2040 AD. This will be a rapid increase in carbon dioxide levels compared to the past.

Annual carbon dioxide production is estimated to have increased from 5500 million tonnes in 1948 to nearly 20,100 million tonnes per year in 1980. This shows an annual growth rate in carbon dioxide production of about 4.3 per cent. About 25 per cent of this total is estimated to be coming every year from the United States alone. North America, Europe (east and west) and the USSR together account for 75 per cent of the total. The problem is, thus, being created essentially by the heavy energy consumption of the developed countries.

Many scientists are, in fact, surprised that atmospheric carbon dioxide increases are only about half of the total carbon dioxide emitted by burning fossil fuels. The major sink is presumably the ocean, which is probably absorbing large quantities of the carbon dioxide released into the atmosphere. But this is a matter of debate and several scientists have suggested other possible sinks.

If the role of oceans is indeed true, some scientists have warned that the rate of increase in atmospheric levels of carbon dioxide in future could be higher because beyond a point the oceans may lose their capacity to absorb so much carbon dioxide every year.

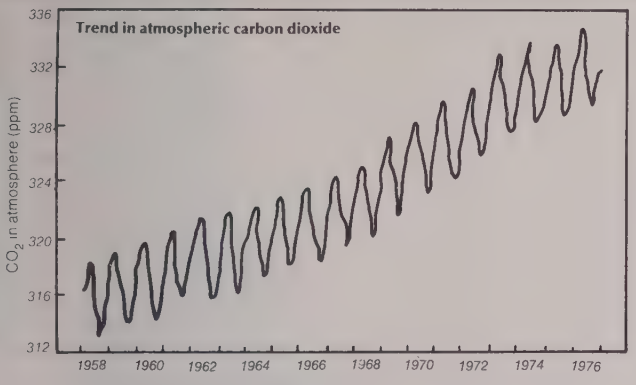
Future increases in atmospheric carbon dioxide will largely depend on continued use of fossil fuels. Although energy consumption in the developed countries may either maintain its present level, or increase at a slower rate, developing countries are expected to use increasingly more energy as they enter the phase of industrialisation. Even with a much lower per capita energy use, developing countries should soon be using more energy in absolute terms.

Increasing carbon dioxide

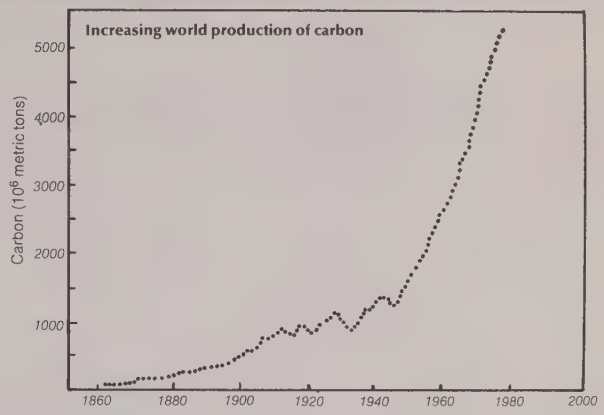
If carbon dioxide production continues to increase at the existing rate, annual carbon dioxide production would reach 51,000 million tonnes by the year 2000, and 178,000 million tonnes by 2025. By 2000, the carbon dioxide conentration in the atmosphere will probably be about 400 ppm and by 2025, between 425 and 500 ppm, with a most likely value of 460 ppm. Burning of fossil fuels alone should cause a concentration of anywhere between 410 to 460 ppm by 2025, with a likely value of 435 ppm. But all increases will not be caused by fossil fuels alone. The extensive deforestation taking place around the world will also contribute. It is difficult, however, to measure this contribution at this stage.

An increase in atmospheric carbon dioxide concentrations is now considered a certainty by most scientists. Only a massive use of solar or other renewable energy sources could possibly reverse this trend. But a large-scale substitution of fossil fuels becoming economically viable in the next two decades is unlikely, even if the price of oil were to continue to rise. Several climate experts therefore suggest

Figure 3. Atmospheric carbon dioxide 1958-76 and world production of carbon since 1860



(Recorded at the Mauna Loa Observatory, Hawaii. Seasonal fluctuations as well as an upward trend are clearly apparent.)



Production of carbon has increased exponentially since the Industrial Revolution.

Source: The world environment 1972-82, UNEP 1982.

that changes in climate will become observable by 2000 to 2005; by 2025 they will certainly become significant.

Effect on biosphere

It is necessary to understand in advance the possible effects of increasing carbon dioxide on the biosphere. Carbon dioxide is the major absorber of the infrared radiation going out from the earth. Greater absorption of infrared radiation will lead to an increase in temperature across the world because of the so-called "greenhouse effect". A global temperature change could trigger events which could lead to global changes in climate. In recent years, computer-based models of general atmospheric circulation, used to study the impact of a doubling of carbon dioxide concentration on the environment, suggest that average global surface temperature — now about 15 degrees centigrade — could increase by 2 to 3°C. The temperature increases could be even more in the polar regions.

The earth should have already warmed up because of increasing carbon dioxide except that it seems the world is passing through a mini-ice age. As compared to the early part of the 20th century, there has been an increase in volcanic activity resulting in more volcanic dust in the atmosphere and, hence, less heat reaching the earth. Moreover, according to studies conducted at the High Altitude Laboratory in Colorado, USA, the sun appears to have been shrinking for the last 40 years and this is also resulting in a cooling of the earth. The Colorado studies show that the sun has a 76-year cycle of expansion and contraction. Thus, the solar effect towards decreasing temperatures and the greenhouse effect of carbon dioxide towards increasing temperatures have been counteracting each other. Now within a decade both the expected solar expansion and the continuing increase in carbon dioxide should lead to an accelerated warming of the earth.

There are still many uncertainties about the magnitude of climatic changes resulting from the warming of the earth and about the geographical regions that would be most affected. There can be advantages and disadvantages to a nation from climatic change and all countries need not be affected equally. It is possible that due to global atmospheric circulation, climatic change induced by increased carbon dioxide is more drastic in a region different from the one where most of the carbon dioxide is being produced.

Some studies suggest that a global warming would be most noticeable near the poles, and that some areas might even be cooler. Europe, Russia and America would all be warmer and drier, but North and East Africa, and Middle East, India, Mexico and West Australia would also be wetter. This could mean massive changes in current cropping patterns.

Good for crops?

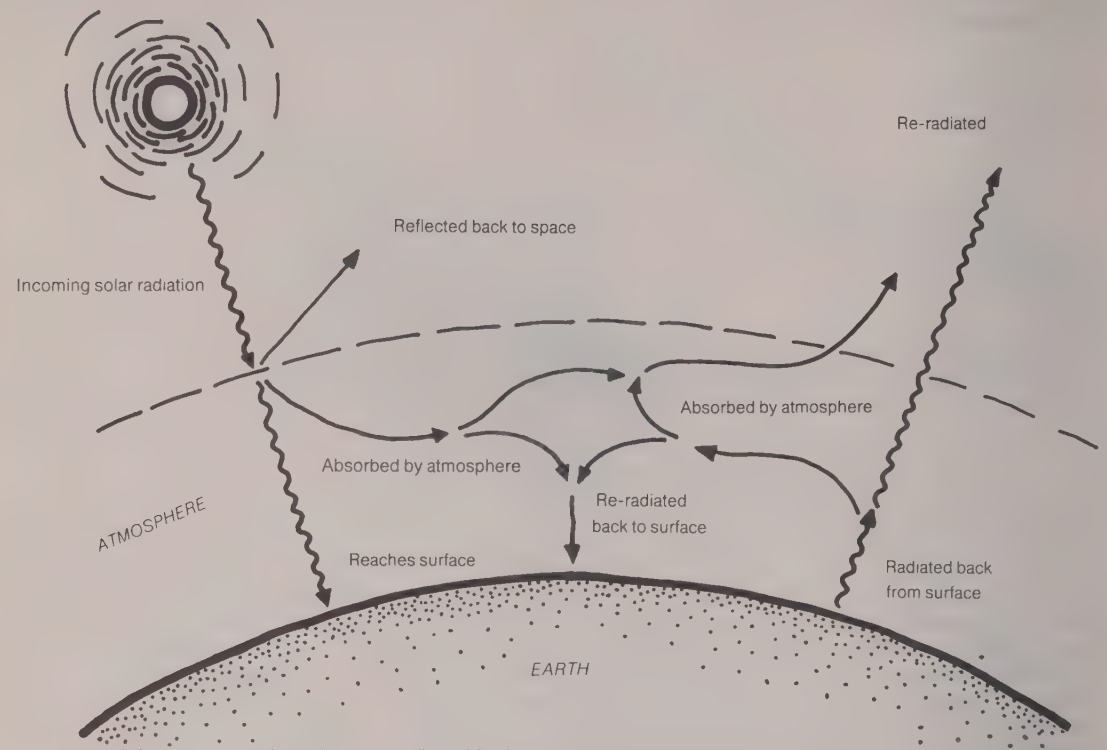
Several climate experts from developed countries are arguing that a global warming will mean increased precipitation in the tropics and hence will be good for the crops of most developing countries. This could shift the global balance of power in their favour.

Writing in "New Scientist", the British Science magazine, Dr John Gribbin points out that "it seems, on this naive picture, that although the Third World countries will produce the greenhouse problem by the early 21st century (because of their economic growth based on fossil fuels), they will suffer little adverse consequences themselves, and may even benefit as a result. Meanwhile, their traditional enemies in the rich North will suffer the worst consequences of the developing world's carbon dioxide pollution."

This scenario is a matter of considerable dispute. Professor S.K. Sinha of the Indian Agricultural Research Institute in New Delhi — one of the few Third World scientists who have studied this problem of increasing carbon dioxide — considers it totally naive. On the contrary, increased temperatures could increase evaporation of moisture from the soil and make climatic conditions worse for agriculture and, hence, lead to greater impoverishment of the developing nations while improving cropping conditions in the already developed nations.

Agriculture is the most important human activity for the sustenance of the human race. Globally, there are only about a dozen nations which produce more foodgrains than they require, including the US, Australia, Canada and Argentina. There are several countries which depend upon

Figure 4. The 'greenhouse effect'



About 40 per cent of the incoming solar radiation is reflected back to space before it enters the earth's atmosphere. Another 15 per cent is absorbed by the atmosphere. Around 45 per cent reaches the earth's surface. Eventually this is re-radiated as heat: most of this heat is absorbed by the atmosphere, while some continues outwards into space. The atmosphere thus absorbs as well as re-radiates both incoming and outgoing energy, and does this in both directions. Carbon dioxide and other molecules in the atmosphere are responsible for this 'greenhouse effect', by which a kind of protective and insulating layer is maintained around the earth.

Source: Earthscan briefing document 25, 1981.

food imports from these countries. Thus, any impact of climatic change on agriculture in these countries is likely to have serious economic and political consequences for the rest of the world.

Several experiments have shown beneficial effects of atmospheric carbon dioxide enrichment on plant growth and yield. Barring a few studies which have appeared in the last few years, however, all carbon dioxide enrichment experiments are based on daytime enrichment and at particular stages of plant growth. The results of these studies cannot be extrapolated to a situation in which there would be a continuous increase in carbon dioxide concentration, particularly when it is expected to be associated with the increase in temperature and, hence, lower water availability in the soil.

Experiments show that an increase in carbon dioxide concentration causes early flowering in tomatoes and cucumbers but delays flowering in many crops, including wheat, sorghum, maize, cotton and sunflower. Delayed flowering with an associated increase in temperature could have serious adverse effects on agriculture in the tropics and sub-tropics. A few years ago, there was a sudden increase in temperature in the third and fourth weeks of February in northern India, which is said to have caused reduction in yields of wheat. An increase of temperature by 2-3°C in central India could increase evaporation by 2-3 mm per day leading to serious water deficits. This could adversely affect crop yields. There is much more use of irrigation in wheat cultivation in Punjab but it does not obtain the high yields that many farmers in West Bengal are getting, even though wheat cultivation is new for them. This is partly because of the higher temperatures that prevail in Punjab during the months in which wheat grains develop, namely March and April.

Therefore, a change in temperature by 2-3°C may increase water requirements, reduce yields, and eventually necessitate a change in cropping patterns. Similarly, Punjab farmers have been getting much higher yields of rice than even progressive farmers and scientists in eastern India, probably because the temperature during the months when grain development of kharif rice takes place are lower in Punjab than in eastern India.

Studies of Syuhuzo Manabe and Ronald Stouffer at Princeton University suggest that tropical and sub-tropical regions, including India, could be most affected because of higher temperatures causing higher evaporation and erratic rainfall. Increased temperature and water deficit would also adversely influence nitrogen fixation in most parts of the world.

Increase in carbon dioxide will affect the biosphere also

in many other ways. Natural ecosystems consist of various combinations of populations of plants, animals, insects and microbes. All these species tend to maintain a balance in the environment. A slight change in the environment due to change in temperature or water availability could influence the population dynamics of various species. Some species might gain an advantage and become dominant forms, whereas others might lose out altogether in the competition.

A considerable change in the pest complex usually takes place with a change of the microclimate (the climate immediately surrounding the plant) due to changes in crop canopy, irrigation, fertilisation application, etc. Pests such as the brown plant hopper and diseases such as blast in rice have become important in Punjab in the last few years. The problem of pests and diseases is much more intense in the tropical countries than in temperate countries.

Looking at the past

Professor Hermann Flohn of the International Institute for Applied Systems Analysis (IIASA) in Austria used an ingenious technique to reconstruct a picture of what could happen to the earth as it grew gradually warmer based on records of what was the actual state of affairs in the world in warmer times in the past. There was indeed a time in the world's history when the globe was on average four degrees warmer, about 12 million to 2.5 million years ago. There was then no ice in the Arctic. It was towards the end of this warm period that the human being's early ancestors, the hominids, started learning to use stones as weapons and tools in the savannas of equatorial East Africa. The scenario of Professor Flohn is as follows:

As the global average surface temperature rises by one degree centigrade, the forests of Canada and Siberia will advance northward. Northern crop yields will increase as lands where grains can be grown expand. But fresh water will dwindle in California, Spain, and the Near and Middle East and agriculture in these areas will get affected.

With the global temperature rising 1.5 degrees, northern forests will reach 200 to 300 km north of present lines. The Sahel region of Africa will regain its woody cover, and subtropical deserts will shrink both north and south of the equator. But droughts will increase in the middle latitudes, where many extensively cropped areas as in USA exist.

With the global temperature up 2.5 degrees, the sea level could rise as much as five to seven metres, inundating large areas, because of melting ice at the poles. Some of the newly cultivated northern cropland would then be under water, and deciduous trees would grow on the Arctic coasts of North America, Europe and Asia. Some scientists, however, do not agree that the melting of Arctic ice will mean a higher sea level. If this is true then this scenario would be wrong.

As the global temperature approaches four degrees above its current level, summer droughts will become more frequent and increasingly severe in much of the temperate zones. The Arctic Ice Cap would completely melt, but the Antarctic would remain ice-covered, dispacing the earth's climatic zones far to the north of their current positions. The air temperature around the massive West Antarctic Ice Sheet is warmest in January and is about -4 to -5°C.

Given these scenarios, it is not surprising that IIASA's study "Life on a Warmer Earth" warns: "A person now 20 years old might see food shortages and population migrations before reaching mid-career."

Figure 5. Number of diseases reported for selected crops in temperate and tropical regions

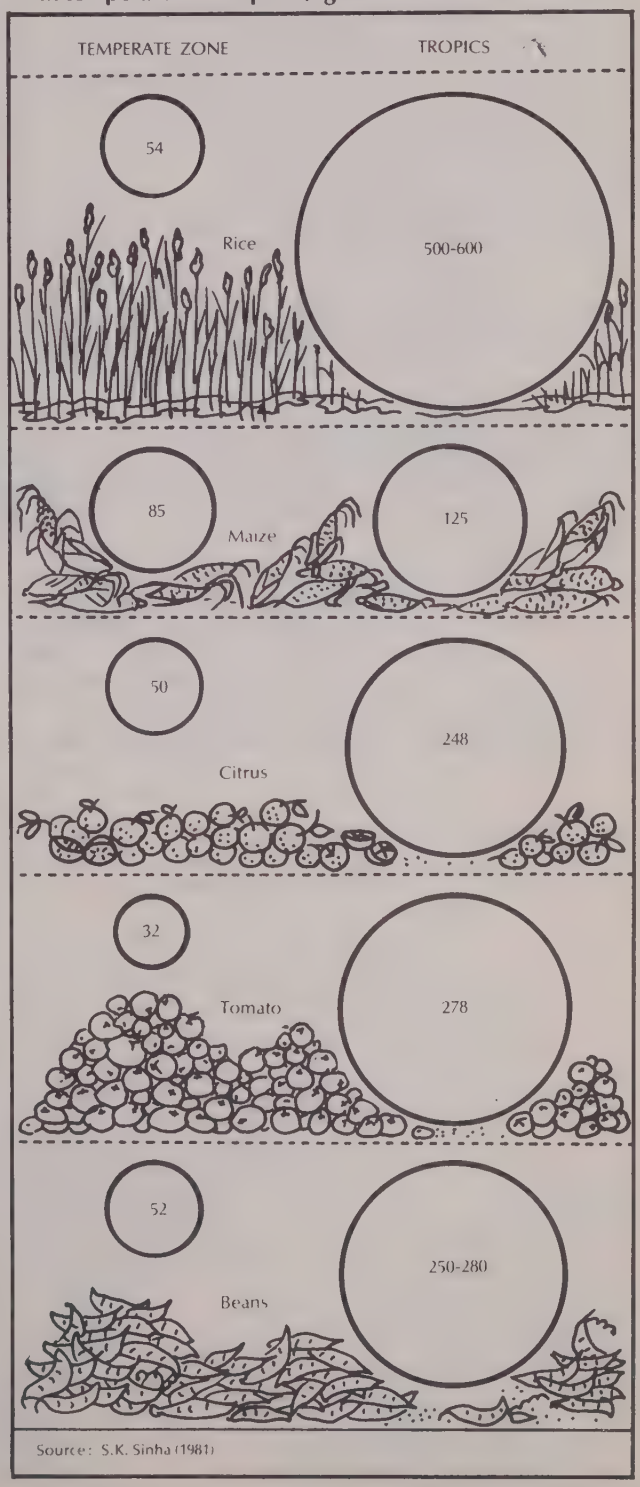
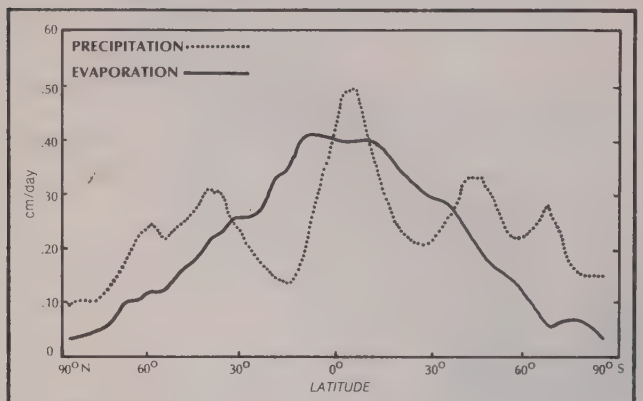


Figure 6. Precipitation and evaporation of carbon dioxide at different latitudes



(Rates of zonal mean precipitation and zonal mean evaporation from the $4 \times CO_2$ experiment)

Source: S Manabe and R J Stouffer, Journal of geophysical research, October 1980.

Who is responsible?

In any discussion on carbon dioxide-induced climatic change, three questions will inevitably arise: who is responsible for the carbon dioxide problems? Who is going to get affected? How can the change, or at least its adverse effects, be prevented?

It would be wrong to hold any nation responsible, and especially the developing countries. Any attempt to reduce their fossil fuel consumption which is expected to increase both in absolute quantities and as a proportion of world consumption, would affect their industrialization programmes seriously.

Rich countries should not be allowed to argue in the future that the fuel consumption of developing countries ought to be kept in check to control the increase in carbon dioxide, regardless of their own contribution in the past. As oil reserves get depleted, the world will inevitably move towards greater use of coal. Over 90 per cent of the world's coal reserves are concentrated in three countries, USA, USSR and China. If the carbon dioxide problem worsens, these countries may not be willing to develop an export trade in coal. Fortunately, India has reasonably large reserves of coal.

Meanwhile, Dr M.S. Swaminathan, the former director general of the Indian Council of Agricultural Research, has proposed that plant breeders in India and other developing countries should go in for "anticipatory breeding" of new varieties of rice, wheat, etc. There should be varieties which can profit from increased carbon dioxide and precipitation or alternatively, withstand the adverse impact of higher temperature and enhanced evapotranspiration. This would be an important task for plant breeders "in preparation for the 21st century", says Swaminathan.

All efforts should be made by developed countries to transfer renewable energy technologies on easy terms to developing countries as greater use of renewable energy systems could instigate the carbon dioxide problem. Unfortunately, these technologies, are also becoming controlled by multinational companies in developed countries and easy access to them appears unlikely.

In the long run, however, the nations of the world ought to move towards an agreement on the control of carbon dioxide emissions. An International Law of the Air, like the International Law of the Seas, is clearly needed. After all like the oceans, the atmosphere is also a common heritage of humanity.

HABITAT

- *India's urban population has doubled in the last 20 years. In the 30 years between 1951 and 1981, Calcutta and Hyderabad have doubled their populations, Greater Bombay Madras and Ahmedabad tripled, and Delhi and Bangalore quadrupled.*

- *The urban housing backlog has grown from 2.9 million to 4.8 million in the last ten years.*

- *Water supply is of a dubious quality in most large cities; and, a third of the urban population — over 50 million people — has no access to latrines of any kind.*

- *Indian roads are amongst the deadliest in the world: nearly 20,000 are killed every year in road accidents, about eight per cent of the world total.*

- *The rural housing problem is so immense but hardly any state has a house building programme in the villages.*

- *Meanwhile, even traditional building materials are becoming scarce. In Karnataka, a poor person has to buy bamboo at Rs. 1200 a tonne to built a house whereas the paper industry gets it as the concessional rate of Rs. 15 a tonne.*

- *Ninety-eight per cent of India's rural population does not have toilets and seventy per cent is without access to safe water supply.*

6

HABITAT

The human habitat has changed dramatically in the last century with more and more people gravitating towards towns and cities. Even though India is still regarded as a rural country, its urban population is extremely large and it exercises an influence over the country's development far out of proportion with its number.

Far higher investments have been made on a per capita basis on urban inhabitants as compared to rural inhabitants, and this has been a matter of contention amongst politicians. However, it is important to note that neither the relatively neglected rural population nor the relatively privileged urban population has been able to meet its needs. As the following paragraphs describe in detail, whether it is a question of housing, water supply, sanitation or transport, problems have only increased. Worst still, there do not see to be any prospects of these needs being met far into the foreseeable future.

Amazingly, this is not just true of India but of virtually every city of the Third World. Both the number as well as the proportion of the urban people living in slums and squatter settlements has been steadily increasing almost, every where. The last 30 years of the 20th century will probably go down in world history as the period when urban chaos came to be the norm rather than an exception.

URBAN HABITAT

Urban India is being crushed by an onslaught of population growth and migration of the poor from small towns and villages. But that is hardly news anymore. Most cityfolk feel the pressures daily as ever increasing numbers awaken on the pavements, defecate in the open, crowd public taps to fill buckets with not-too-clean water and jam into overcrowded buses, trams and trains in a mad scramble to earn their daily bread. Unable to meet this staggering demand for basic civic amenities, our cities have become teeming hovels of dirt, disease and crime.

Hundreds of small and medium-sized towns in India are dying from total neglect. Lack of investment in industry and infrastructure is pushing small town residents into the big metropolises.

The urban population has more than doubled in the past 20 years, from 77 million in 1961 to 156 million in 1981, according to the latest census and this growth in urban population has accelerated over the last decade. Half of this increase could be attributed to rural-urban migration, argues a population expert in "The Times of India". Despite large investments made in urban development, much to the neglect of rural areas, millions of urban dwellers still continue to live with woefully inadequate housing, water supply, sanitation, transport, education, law enforcement and disease control.

City housing lags way behind the soaring demand. Compared to an annual need of eight new dwellings per thousand population, only 1.8 are being built, causing a spillover of the excess population into slums. Huge slum colonies, multiplying two to three times faster than their cities, are gobbling up the major towns and cities in the country. Squatter families — whether in Calcutta's bastis, Bombay's chawls or Kanpur's ahatas —crowd into dark cubicles and makeshift hovels of wood, mud, hesian, cardboard and other assorted materials.

Lack of drainage leads to stagnant pools of water and intermittent flooding during the rains. Absence of sanitation facilities forces people to defecate in the open. The construction boom has closed in on all available open spaces and slum men and women trudge long distances looking for a place to squat. Human and animal excreta and garbage pile up right next to their shacks, causing severe health hazards and high rates of infant mortality. The fire hydrant is often the only source of water supply.

All the major cities, Bombay,Calcutta, Madras and Delhi are in the grip of an intractable water crisis. The government claims that in 1980, 42 per cent of the urban population had house connections. Of the remaining 58 per cent, 39 per cent were served by public standposts and the rest had nothing. But water need not be available in all taps at all times.

Unplanned roads, biased heavily in favour of the car, and the concentration of urban activity in dense inner city locations has made movement in Indian cities a daily ordeal. "In Bombay and Calcutta .... about three million people are disgorged each morning at the railway stations and bus terminals, choking the streets, bottling up traffic and stretching the city's infrastructure to its limit", observes the fortnightly "India Today".

Urban demography

Seventy per cent of the increase in urban population in the last 10 years has occurred in class I cities (populations above 100,000). In 1901, Calcutta was the only million-plus city in the country. By 1951, Bombay, Delhi, Madras, and Hyderabad also had over a million residents. In the next 30 years seven more cities — Ahmedabad, Bangalore, Kanpur, Pune, Nagpur, Lucknow and Jaipur — joined the million club. These 12 cities now account for more than a quarter of the nation's urban population.

The trend towards rapid city growth is not peculiar to India. All over the developing world people are flocking to the cities. Over the past 25 years, Third World cities have grown at nearly twice the rate of the overall population

Table 1. Towns and urban population, 1951-81

Class/Population	Number of towns				Percentage of total urban population			
	1951	1961	1971	1981	1951	1961	1971	1981
I/Over 100,000	74	102	145	216	44.31	50.77	56.21	60.37
II/50,000 to 99,999	95	129	178	270	9.95	11.00	11.24	11.65
III/20,000 to 49,999	330	449	570	739	15.79	17.41	16.32	14.35
IV/10,000 to 19,999	621	732	847	1048	13.79	13.00	11.20	9.52
V/5,000 to 9,999	1146	739	641	742	13.04	7.03	4.57	3.61
VI/Below 5,000	578	179	150	230	3.12	0.79	0.46	0.51

Source: Census of India, Series 1, paper 2

growth. Today they contain about 900 million persons. United Nations projections estimate that by the year 2000, one out of every three Asians and Africans and three out of every four Latin Americans will be urbanites. With three quarters of India's population still living in villages, its cities will continue to be swamped by rural migrants well into the nineties.

Between 1951 and 1981, Calcutta and Hyderabad doubled their populations, Greater Bombay, Madras and Ahmedabad tripled their numbers, while Delhi and Bangalore multiplied four times. Bangalore is now the fastest growing metropolis in the country.

While the large cities are bursting at their seams, the small and medium towns in the country are stagnating. Since 1951, Class V and Class VI towns have halved in number. While Class I towns increased their share of the total urban population from 44 per cent to 60 per cent in the last 30 years, the share of towns with less than 20,000 people (Classes IV, V and VI) has diminished from 30 per cent to only 14 per cent. Since 1901, the total Class V population has levelled off at five to six million and Class VI towns shrank from 1.6 million in 1901 to a mere 0.8 million 80 years later.

Successive government documents on human settlement policies have waxed eloquent about the need to develop these towns "by providing genuine incentives for locating appropriate economic activities and work centres". But precious little has been done. The annual plan expenditure has failed to divert more economic and commercial activity to small towns.

HOUSING AND SLUMS

The backlog in urban housing rose from 2.9 million houses in 1971 to 4.8 million in 1981 and is estimated to jump to 7.2 million by 1991, reports the National Buildings Organisation. This deficit is already beyond governmental housing targets.

Bombay's population has increased from three million in the fifties to a current eight million; it is expected to stablise around 16 million by the end of this century. Three hundred new families stream into the city every day. Two out of every five of these families end up on the city's pavements where 500,000 people already make their homes.

The city's housing situation is a disaster. Eighty two per cent of the city's population lives in one-room abodes including slums. Of these 1.5 million live in chawls with common toilet facilities. A shortage of 55,000 housing units is added every year to a previous backlog of 800,000 houses. Bombay's housing crisis has been compounded by the rapid deterioration of its old housing stock. Fifteen per cent of the citizens live in 11,000 buildings which are on the verge of collapse, revealed a survey of the Bombay Municipal Corporation (BMC). Another 20,000 have a remaining lifespan of only five to 15 years.

The result has been a prolific growth of slums. Dharavi, stretching between Matunga, Sion and Bandra, with half a million squatters, is amongst the world's biggest slums.

If Bombay exhibits all the evils of a thriving Third World metropolis, Calcutta shows all the signs of a decaying city. Contrary to popular impression, Calcutta's population growth has slowed down to a trickle. The metropolitan district grows at a little over three per cent a year as compared with a national average of 4.6 per cent for urban areas. The growth rate for Calcutta city declined from 0.76 per cent in the sixties to 0.45 per cent in the seventies.

Calcutta's housing mess has its origin in its rise as a centre for colonial commerce and industry, especially in jute, textiles and engineering goods. In the absence of a civic infrastructure, thousands of incoming labourers were housed in shacks erected on tracts of fallow land in and around the city. These slums now house 3.6 million people or 40 per cent of the metropolitan population. According to the Calcutta Metropolitan Development Authority (CMDA), two thirds of the population lives in "kutcha" (temporary)

In Bombay, 1.5 million people live in one-room tenements or chawls. On each floor, tenants share common baths and toilets. (India Today/Pramod Pushkarna)

buildings and more than 57 per cent of multi-member families have only one room to live in. The CMDA estimates an annual demand for 50-60,000 houses every year. Private and public sector housing can build only 20,000 units a year, nearly all of which are geared to the high and medium income category.

"Nearly 400,000 houses in Madras are decrepit, which amounts to half the city's housing stock", writes B. Natarajan in the "Economic Times". According to another recent study, housing demand in Madras is projected at 700,000 in the next two decades, half of them for the poor.

Housing the poor

Since the housing needs of the rich and the middle class are largely taken care of by most private and public residential construction, it is the poor who bear the brunt of the housing crisis. In Ahmedabad, 85 per cent of the existing housing deficit affects low-income people. In the city's slums 415,000 people lived in 1976, and another 300,000 were herded into insantitary chawls. Pune's slum population doubled between 1950 and 1968, and then tripled in the next eight years. Between 1961 and 1976, Kanpur's slum population increased by 133 per cent.

Many experts now realise that slums are formed because their residents cannot afford the poorest housing in the market. "The housing schemes of the Government generally benefit people in the organised sector, those who have steady incomes or reserves to fall back upon to enable them to pay the instalments of the housing boards," asserts M.N. Buch, Director, National Institute of Urban Affairs in New Delhi.

According to a World Bank study, as many as two-thirds of the urban households of Madras and Ahmedabad cannot afford a house of Rs 5000: the cheapest that modern construction technology can build. As a result, so-called low-cost housing schemes inevitably become middle-class.

The Planning Commission itself has recognised the utter inadequacy of current government housing programmes. By 1997, a working group of the commission reports, the urban housing backlog would be around 4.89 million and the present rate of construction (public and private) is 0.25 million dwellings per year. "No public housing programme can meet such a gigantic requirement even over 20 years", argues P.S.A. Sundaram of the Union Ministry of Works and Housing.

The slum riddle

In today's soaring real estate markets, slums have come to occupy prime urban land. Slums are also eyesores, a violation of modern norms. "The middle class tends to treat slums as a virulent social disease," says A. Bopegamage, an urban sociologist from Pune. "The police see them as dangerous deviants of law and order, the municipalities view them as inefficient users of real estate, the town planners regard them as sore spots on the urban landscape and social workers treat them as destitutes and criminals".

Slum demolitions may make economic sense by freeing land for profitable redevelopment, but they complicate the lives of the poor. Demolitions wipe out the investment of slum residents and landlords. They also disrupt the social and economic relationships which the poor create in the slums. These bonds are reflected in a high level of lending and borrowing, in mutual supervision of homes and children, and in the joint celebration of festivals. Even the small space outside the shack has a functional value — for keeping animals, performing household chores, and housing the slum family's entrepreneurial activities. These functions do not get a place in the congestion of low-cost, high-rise tenement housing.

The failure of Calcutta's attempt at clearing slum land and building multi-storeyed structures to house the displaced community highlights these problems. Even when the

The slum that is Kanpur

Kanpur was once a bustling industrial town. Today it is a giant slum colony with nearly half of its 1.6 million people living in squalid insanitary conditions.

The city's decay is not just due to its rapid population growth — from 2,02,800 in 1901 to 16,87,000 in 1981. The reason is neglect of basic civic services by its urban planners and the city's wealthy industrialists' lack of interest and investment in it. A financially starved infrastructure has led to the mushrooming of slum colonies, locally known as "ahatas", now numbering 780.

New housing lags behind demand. Two thirds of the city's households live in single room tenements and according to a report published by the Urban Community Development Programme, a little under half of the city's population can be classified as slum dwellers. Half-hearted government efforts at industrial housing and the improvement of city slums have failed to make a breakthrough. Due to lack of funding, the most critical ahatas have never been touched. A World Bank initiated slum improvement programme has now been launched as well as one for forwarding credit for 15,000 low-cost houses. This should accelerate the rate of new housing development which had stagnated at 1000 new houses per year.

The civic amenities are in a worse state than the housing. Only a seventh of the city area is sewered and even these sewers have been cleaned only once in the past 15 years. In a number of Kanpur's industrial colonies, defecating on rooftops and flushing the excreta into open street drains is common practice. The drains also receive a fair share of animal wastes as milk dairies operating on road sides and foot-paths wash huge amounts of cowdung into them.

Of the 647 factories in the city, only three possess effluent treatment plants. The rest run their waste water and industrial effluents into the river Ganga. The daily occurence of huge fish kills, caused by discharge of almost 200 million litres of waste and toxic water into the river every day, are just one more graphic reminder of the city's desolate state of affairs. River pollution has depleted fish stocks; fisherfolk complain that their average catch has trickled down to 15 kg per day from around 30-60 kg.

Nearly 150 tonnes of garbage, out of some 900 tonnes generated each day, remain uncollected and lie in huge waste dumps all over the city. The composting plant can handle only 350 tonnes a day; the rest is dumped into vacant sites.

The effects of these overcrowded and insanitary conditions are seen on the health of the city's populace. The Kanpur Development Authority estimates that 60 per cent of the city's slum children, below six years of age, are infected by tuberculosis — the highest incidence of TB in the country. A third of the slum dwellers are reported to be "continuously sick", according to one survey, resulting in high rates of worker absenteeism — often more than 60 working days per year per worker.

The condition of Kanpur is a warning to India's other rapidly growing cities. Neglect today could lead to the creation of many more Kanpurs tomorrow.

costs were subsidised by developing a portion of the plot for commercial purposes, the slum families refused to pay the monthly rent of Rs 98. Subsequent rent reductions to Rs 25 and then to Rs 18 also failed. Most of the householders sublet their one-room blocks and went back to squatting. In the last 25 years, Calcutta's efforts at rehousing have benefitted only one per cent of the city's slum population.

Resettlement of the poor in far flung colonies have also not worked since the poor tend to sell or desert their lots to the better-off and come back into the city.

Upgrading slums

Unsuccessful resettlement programmes in India and elsewhere have forced urban planners and financial agencies like the World Bank to think differently. Since proximity to city centres, which provide employment opportunities, is a prime need of slum residents, a new approach based on physical improvement of existing slums is being advocated. Slum upgrading, as this approach is called, involves providing essential services like community water taps and sanitation, paved pathways, surface drainage, and electricity. This approach also capitalises on the desire of the homeless to house themselves.

Foxes have holes and the birds of the air have their nests, but the children of Calcutta know not where to lay their heads. (Earthscan/ Mark Edwards)

Slum upgrading is drastically less expensive than resettlement. In Calcutta, resettlement costs Rs 5000 per capita compared to Rs 250-300 for upgrading. Even a skeletal house, if provided, costs at least Rs 2000 per capitá. Yet in Calcutta, after 10 years of slum upgrading under World Bank assistance (to be completed by 1984), CMDA's planners insist that upgrading is only a temporary solution and that the CMDA actually plans to rehouse all the four million squatters of the city. Clearly, there is more lip service paid to the idea of slum upgrading than an actual commitment to the new approach.

In recent years the Government of India has often asserted that the slum eviction approach has been abandoned in favour of improvement of existing slums. "The National Plan virtually abandons the effort to clear slums," says a report submitted by the Indian Government to the UN Commission on Human Settlements in 1979. Efforts at upgrading, however, are isolated, mostly initiated by international agencies like the World Bank.

The Government is reluctant to go in for approaches like slum upgrading because slums are usually located on prime real estate. There are also political advantages in providing "complete" houses to the poor. Laying down infrastructure hardly has the same visual appeal. "There is definite antipathy of architects and engineers towards designing shelters for the poor," says M.N. Buch. "It denies the architect the place in history which the monumens would have done and it denies the engineer and the administrator the share in booty which expensive structures in brick and concrete would have yielded", he argues.

The only working policy that the State governments still follow is that of slum eviction. For three days between May 30 and June 1, 1980, demolition squads of the Delhi Development Authority (DDA) bulldozed the homes of poor residents in three "jhuggies", the squatter colonies of New Delhi. In March 1981, hundreds of structures at Vinod Nagar in New Delhi were destroyed by the DDA, although the owners had paid house-taxes regularly. The most notorious incident occured in Bombay in July 1981 when the then State Chief Minister, A.R. Antulay, personally ordered the demolition of a squatter colony, rendering 2000 homeless in the midst of a torrential monsoon downpour.

Slum evictions are particularly insidious because often they destroy long-established homes, with no offer of alternative resettlement. "When a demolition occurs, we are not responsible for where the people go, because the slum was not authorised," says the Public Relations Officer of the Bombay Municipal Corporation. Slum clearances also violate civil liberty laws.

The soaring price of urban land — upto 50 per cent in some places — will continue to make slum upgrading impossible. The going rates per square metre of residential land in big cities ranges from Rs 400-600 in Cochin, Dehradun and Bhopal to Rs 1500-2000 in Calcutta, Bombay, Bangalore and Delhi. This property boom has put housing out of the reach of most urban families. The Government's lack of political will to enforce the Urban Land Ceiling Act of 1976, which would have freed valuable acres of land, has aggravated the situation.

In December 1981, the Union Minister for Works and Housing, Bhishma Narain Singh, announced that the Government had drawn up a 10 year plan to provide houses

Table 2. Water supply in urban areas

Class/Population	Number of towns	Number with water supply	Total population (millions)	Population served (millions)	Percent Population served
I/Over 100,000	151	149	53.380	50.672	94.9
II/50,000 to 99,999	219	206	14.712	12.480	84.8
III/20,000 to 49,999	652	542	19.947	15.197	76.2
IV/10,000 to 19,999	987	649	13.961	8.504	60.9
V/5,000 to 9,999	820	423	6.197	3.171	51.2
VI/Below 5,000	290	123	0.896	0.359	40.1
Totals	3,119	2,092	109.093	90.383	82.9

NOTE: Population figures are for 1971.

Source: Sixth Five Year Plan (1980-85), Planning Commission

for the country's 33.5 million slum dwellers. Forty per cent of them would be covered in the Sixth Plan, he added. If Calcutta's slum upgrading costs of Rs 300 per capita are assumed unchanged (those figures are for 1970), then improving the housing conditions of 33.5 million slum dwellers would cost Rs 1005 crores in the next 10 years. The Sixth Plan expenditure for slum improvement is only Rs 151 crores. Clearly, the Government will be faced with an impossible task of raising these vast sums of money. The plan could simply remain on paper.

WATER SUPPLY

Almost 24 per cent of India's population is squeezed into towns and cities covering just 1.3 per cent of the country's land area. Overcrowding of this magnitude, 156 million people in 1981, has severely curtailed the availability of clean water in India cities.

India's Sixth Plan document claims that nearly 83 per cent of the urban population has been provided with drinking water facilities (see Table 2). This coverage is biased in favour of the big cities. Out of 1027 towns lacking drinking water supply systems, 902 are Class IV, V and VI towns with populations below 20,000.

According to a survey conducted by the Central Public Health and Environmental Engineering Organisation (CPHEEO) of the Ministry of Works and Housing, the per capita consumption rates in March 1978 varied from 10 to 400 litres per day (lpd) in the different towns. "The quantity supplied is inadequate in a majority of the places", states the survey.

Per capita demand figures usually quoted include average requirements for domestic, commerical, institutional and industrial purposes. The Union Ministry of Works and Housing recommends 70-100 lpcd (litres per capita daily) for Class V and VI towns (below 10,000 population); 100-125 lpcd for Class III and IV (between 10,000-50,000 population) and 125-200 lpcd for Class I and II (above 50,000 population).

The CPHEEO report assesses that the present average per capita consumption rates are 50 lpcd in Class V and VI tonnes; 75 lpcd in Class III and IV towns and 125 lpcd in Class I and II towns.

A survey conducted by the Central Board for the Prevention and Control of Water Pollution (CBPCWP) in 1978-79, estimated the average water supply in Class I cities to be 145 lpcd.

Data in Table 2 show that six out of the nine cities with populations over a million each in 1978 were below the CBPCWP estimate. The discrepancy with the CBPCWP figure is apparently due to the latter's use of 1971 population data to determine the per capita supply. The actual amount that reaches the consumer in these cities is probably another 15 to 20 per cent less due to leakage losses and illegal diversions from the mains.

Urban water supply is further prone to seasonal shortages and frequent cuts. Bombay was rocked twice in less than a year by angry citizens protesting against water supply failures. In December 1980, residents of the Girgaum area staged a "rasta roko" (literally, stop the streets) agitation after being denied a drop of water for three consecutive days. A similar occurrence in Lalbaug on October 9, 1981 turned violent. Police firing killed one citizen and injured several others. Several cars and buses were burnt.

The hardest hit sections are, of course, people living in the slums. In most cities slum dwellers get their water supply from fire hydrants and public standpipes. In the slums of Beckbagan, right next to the Calcutta Metropolitan Development Authority's sprawling headquarters, the public taps have been dry ever since they were installed under the slums improvement scheme nearly five year ago.

The water situation in Madras is indeed desperate. The per capita availability of barely 55 lpd, far below 182 lpd recommended by the UN for an equivalent city, creates chaotic scenes every day. Large groups of men, women and children fill their buckets at the public fountain in Saidapet throughout the small hours of the morning. They take the suburban train to St Thomas Mount, a locality seven to eight km away, empty their vessels and catch another train for a refill. When the train gets crowded during office hours, the activity shifts to the Meenambakkam station, which has a well adjacent to it. Water sells at 30 paise a bucket in St Thomas Mount. There is now a proposal to shift the State capital from Madras to ease the city's water crisis, reports the "Economic Times".

In some of the large cities, hours of water supply dropped from 8-10 hours in 1970 to about two to three hours by 1975. This creates a health hazard. Since sewers and water mains are often laid side-by-side, raw sewage tends to get sucked into the water mains when the pressure is reduced or shut off.

Unfit for consumption

Faecal contamination occurs frequently in Madras. A report on Madras, prepared by the Chief Water Analyst of Tamil Nadu states, "In general, the entire water supply to the various Metropolitan divisions has to be condemned as unfit for human consumption from the bacteriological point of view as more than 96.5 per cent of the samples tested show evidence of recent faecal contamination".

Sixty one per cent of the water supply of Class I cities comes from surface sources, 9 per cent from ground water and the remaining 30 per cent from a combination of these sources. By 2001, 15 per cent of the urban demand may have to be met from the ground water, according to the CPHEEO study.

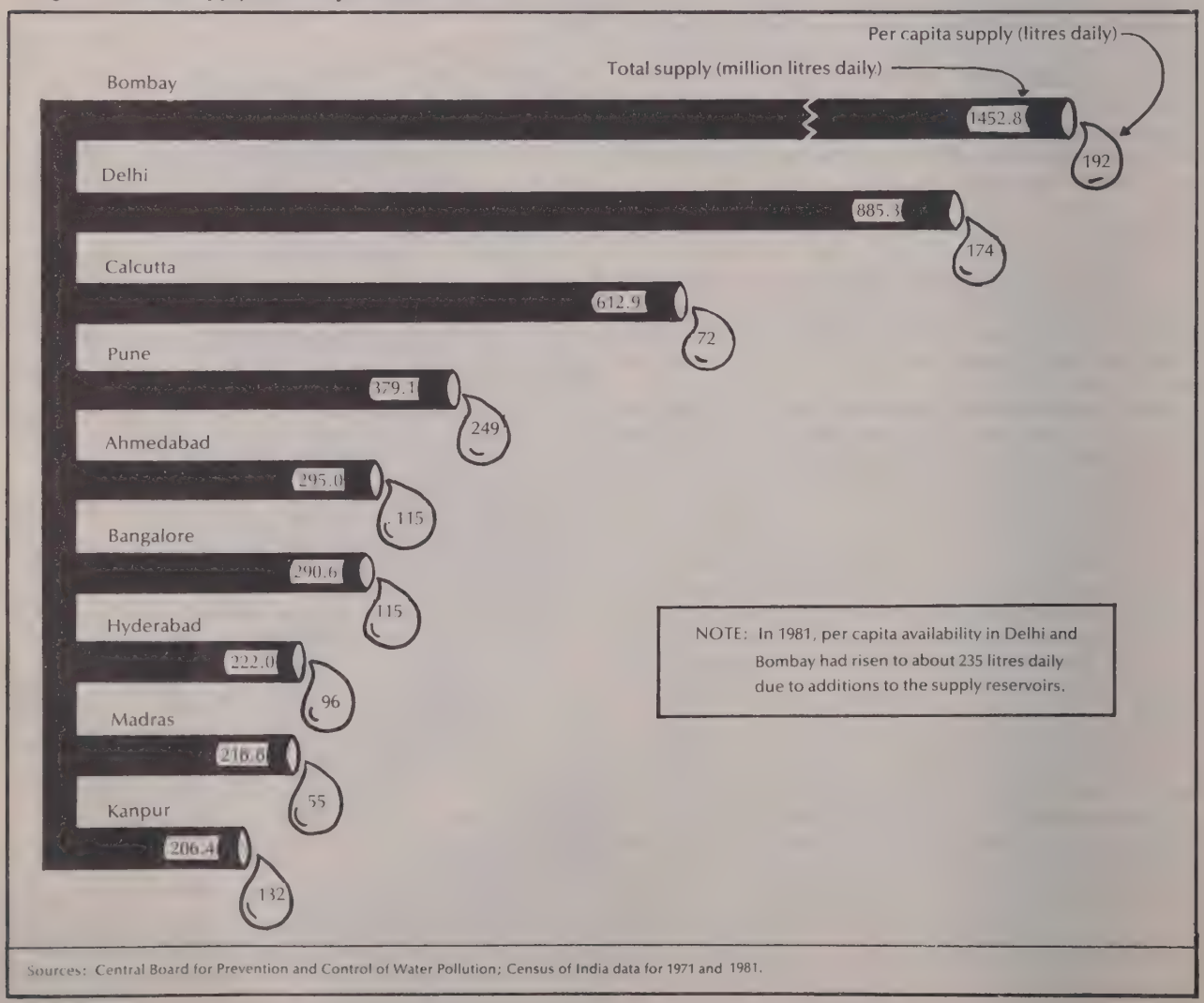
Ahmedabad city already faces the problem of over-used ground water resources. Since 1979, the Sabarmati river which was the city's main source of water, has been largely dry. Sixty per cent of Ahmedabad's total water supply comes from 450 tubewell stations. This high tubewell density, five per sq km, is lowering the city's water table by 1.5 to 1.9 metres a year and raising the pumping costs. The heavy demand for water by the city's textile industry is also responsible for the lowering of the water table.

A low priority

Poor maintenance of water pumping and treatment plants aggravates the urban water supply crisis. B.B. Sundaresan, director of the National Environmental Engineering Research Institute, explains: "Pre-treatment units .... have gone out of order within a short period after erection. Chlorinators under working condition are hard to find. Filter units have been found defective due to poor operation and maintenance. Optimum utilisation of water treatment plant capacity has rarely been attempted."

In 27 years of planning, from 1952 to 1979, total planned

Figure 1. Water supply in metropolitan cities, 1978



Sources: Central Board for Prevention and Control of Water Pollution; Census of India data for 1971 and 1981.

investment in urban water supply and sanitation programmes amounted to only Rs 1185 crores. Almost half of it, Rs 539 crores, was allocated in the Fifth Plan (1974-1979). Investment in urban water supply was apparently not a high priority during the first four national plans.

India is a signatory to the UN resolution declaring 1981-1990 as the International Drinking Water Supply and Sanitation Decade, which calls for provision of safe water and sanitation for all people. Only 35 per cent of the Rs 4975 crores needed for providing safe water and sanitation to all urban residents by 1990 have been allocated in the 1980-85 Sixth Plan period.

At the present rates of consumption and population growth of the different classes of towns and cities, 24,739 million lpd or 24.75 million cubic metres per day (M cu m) will be needed by India's urban citizens in 1991. While the CPHEEO survey estimated a consumption of only 9.87 M cu m per day in 1978, it has calculated a demand of 39.12 M cu m per day in the year 2001 for urban India. This figure appears low, mainly because of an assumed rate of urban growth of only 1.6 per cent in the nineties.

If plan targets are based on these calculations, our planners might face the fate of Sisyphus, at the bottom of the hill, in 2001 AD. Moreover, with drinking water sources getting polluted fast, it is doubtful whether such large quantities of water can be easily procured.

SANITATION

Urban India is a collection of stink chambers. Enter any Indian town or city by road, rail or air and you will be immediately assaulted by the odour of garbage and excreta.

Next to poverty, the most depressing feature of India is its ability to ignore the surrounding filth and unhygienic conditions. Education, wealth distinctions and environmental concerns vanish quickly as everyone succumbs to do the convenient—smoking in crowded spaces or, spitting, urinating or just tossing out the garbage into the open.

The average urban garbage disposal rate is about 0.35 kg per person per day. The urban total is about 20 million tonnes a year. Removal of garbage costs several crore rupees. In 1973, a top public health official estimated it at Rs 20 crores. Composting, which would save a lot of money, is rare, and so is sanitary land filling. Garbage is usually left lying in the open, spreading illness and disease, and is eventually burnt.

Open air defecation is a common practice. These human faeces spread cholera, typhoid, dysentery, diarrhoea and jaundice. At least a third of the urban population—well over 50 million people—do not have access to latrines of any kind. Another third are served by bucket latrines which are hardly sanitary. The rest, mainly in the large cities, have access to sewered facilities. In small and medium towns, excreta is often flushed into open drains along the street.

The 1978-83 Plan draft prepared by the Janata Party's Government stated that only 217 towns have sewerage facility, in most of them it covers only a part of the population, and that only 34 per cent of the urban population has sewerage facilities. Two years later, the Sixth Plan (1980-85), prepared by Mrs Gandhi's Government, claimed an urban population coverage of only 20 per cent spread in 198 towns.

A sewerage system is highly capital intensive and out of the reach of the average urban household. For many poor urban households, getting a sewer connection could mean an expenditure of Rs 6000, equivalent to 12 to 20 years' rent—the cost of a television set. As a result, not more than 10 per cent of the urban population has domestic connections to sewerage systems, which are being utilised well below capacity in almost all towns of India.

As mentioned earlier, the International Drinking Water Supply and Sanitation Decade has set a target of providing sanitation to everyone by 1990. The Indian Government has reset a slightly more modest goal of 80 per cent coverage of the urban population. By 1990, sewerage facilities will be provided to all residents of Class I cities which numbered 216 in 1981, and at least 50 per cent coverage in other cities. During the Sixth Plan period, 120 urban sewerage and drainage programmes will be completed and new sewerage schemes will be taken up in 110 towns.

Cheap latrines

The Government of India, with the assistance of the United Nations Development Programme (UNDP) and the World

Once upon a time Shillong

Set in the smooth undulating Khasi hills of Meghalaya, Shillong was once a beautiful hill town. Its lake, its picturesque houses, its hillsides covered with tall pines, attracted the hot and sweating hordes from Calcutta during the summer months.

Today, although some of its beauty remains unaffected, Shillong exemplifies in most ways the neglect so common in urban India.

In spite of being the premier town of the entire northeastern region — it was the seat of government for Assam State since British days — Shillong has no sewerage system. Eighty per cent of the latrines in the city are service latrines which are cleaned by headload carriers. The night soil is dumped outside the city. A rapidly growing population — the growth rate was 19.88 per cent between 1961-71 and accelerated to 40.88 per cent between 1971-81 — makes this particular problem even more acute.

A combination of this lack of adequate sanitation facilities, and deforestation of the hills around, has affected the quantity and the quality of the city's water supply. The streams of Shillong Peak, one of the highest in the State of Meghalaya, supplied water to the city. It was a densely wooded area and a large sacred grove kept the area unpolluted. Today the forests around the peak are being cut, the area is not protected from human interference. Consequently the amount of water yielded to the city cannot match the demand of its 1.73 lakh citizens. The Shillong Municipal Corporation is only able to supply 25.38 lakh lpd. People get water for one hour in the morning and one in the evening. According to the recommendations of the Union Ministry of Works and Housing, a Class I city like Shillong should receive at least 216.25 lakh lpd.

Lack of water and a primitive sanitary system have made Shillong citizens continuous victims of dysentery, diarrhoea and gastroenteritis.

The system of landownership in Meghalaya — under the Sixth Schedule private landownership is permitted — poses special problems for the city administration in implementing many aspects of the master plan for Shillong prepared in July 1976. There is no updated base map of the city indicating ownership patterns and physical features. There are tree different authorities which can issue "pattas" (ownership certificates). Thus encroachments on government land cannot be checked or even detected and any orderly development of the city, specially in the sphere of housing, is halted.

Thus Shillong presents the picture of a State capital with uncontrolled growth, few amenities and increasingly unhealthy conditions.

Bank, is going ahead with a massive pilot project to install cheap hand-flushed latrines in 11 towns spread in seven States. Emphasis will be on covering small and medium-sized towns. The programme is likely to cost about Rs 40 to 45 crores and if successful, it will be extended to all the remaining towns in the country.

Each latrine is connected to a twin leach pit. When one pit is nearly full, the municipality will clean it free and earn revenue by selling the compost.

The cost of conversion of an existing latrine to, or provision of a new, water-seal latrine, will be around Rs 500. With an eight per cent interest rate and a 20 year loan period, each family will have to pay about Rs 5 per month, according to A.K. Roy, a former Chief Engineer of the State of Uttar Pradesh and a consultant to the World Bank.

Composting the excreta will help mitigate the problem of dumping raw, untreated sewage into the nation's rivers, lakes, ponds and seashores. Only 47 per cent of the sewage in the 151 larger towns is fully treated. The rest is partially treated and spread on land as fertiliser or discharged into the rivers. Delhi's wastewater plants treat about 46 per cent of its daily load and discharge the rest through 17 open drains into the Yamuna river.

Difficulties

The Government's programme to improve urban sanitation in the current decade faces several difficulties besides the financial ones. "As much as 25 per cent of the country's target population has no space even for construction of latrines," argues Roy. For them community latrines will be needed. This will require social, organisational and a massive civic education effort to ensure maintenance. Trained or dedicated sanitary engineers are hard to find.

Responsibility for urban sanitation rests with municipal bodies, most of which are in a disarray. Many towns and cities have not had elections for their municipal bodies for several years. The holy city of Varanasi, without an elected city government for over five years, can now boast that "uncleanliness is next to godliness".

Women are the most adversely affected by inadequate sanitary facilities. Every morning they have to get up before dawn — that is before the men — to squat. The situation gets worse everyday. During the day, they either use the roof top or wait until the sun goes down. Rajasthani women in several small towns now go out for squatting in small groups and enclose the space by tying a sari around.

A poor person's toilet

Patna has the reputation of being the dirtiest capital in the country. But it may soon lose that distinction. More than 25,000 poor people who previously fouled the streets and parks, now use the string of public baths and toilets set up by a non-governmental organisation called Sulabh International. Long queues are now a daily feature at Sulabh toilets at the railway station and city squares. "Every rickshaw puller in Patna now bathes twice a day," remarks Bindeshwar Pathak, chairman of Sulabh International (previously known as the Sulabh Shauchalaya Sansthan) and the moving spirit behind the movement.

Sulabh's public facilities have been built on land donated by municipalities. The maintenance cost is covererd by collecting a fee of 10 paise from those who can afford it, and most users pay. "The daily intake of this complex often exceeds Rs 300", says Krishan Lal who manages the unit near the railway station.

For more than a decade Sulabh has also been organising a door to door campaign to popularise low cost flush latrines in various parts of Bihar. Over 500,000 units have already been installed, and another 10,000 have been converted from existing bucket privies.

The Sulabh Shauchalaya (latrine) is an improved version of the standard hand-flush latrine. A specially designed pan and waterseal trap is connected to a pit,three feet square and four to five feet deep. The excreta undergoes bacterial decomposition and is transformed into high quality manure. Once the pit gets filled (three to five years for an average family) the manure is dug out and the pit becomes ready for use again.

The total cost of the Sulabh latrine is Rs 700. The State government gives Rs 350 as grant and the remaining Rs 350 as loan repayable in easy instalments. Sulabh is financed by charging the customer 10 per cent of the construction cost.

Its low cost and low water consumption makes the Sulabh latrine a better and more feasible alternative to sewerage systems and septic tanks. However, lack of complementary research is a shortcoming in this unusual programme. For instance, the risk of contaminating groundwater supplies by bacterial contamination from the pit latrines needs to be studied. According to a WHO study of the Sulabh latrine, the size and depth of the leach pits, the exit area for dispersion of effluent into the soil, and most other data are based on rule-of-thumb assumptions. The report recommends a study of the latrines under varying conditions. Pathak eagerly welcomes such research efforts.

"It is only committed voluntary agencies like Sulabh, with financial and political independence, which can catalyse government organisations into development work," asserts Pathak. Sulabh International is now a sought-after organisation and has spread its activities to Andhra Pradesh, Haryana, Madhya Pradesh, Uttar Pradesh, Orissa, West Bengal and even Sri Lanka.

K.M. KISHAN

"The sanitation problem has yet to receive serious attention", comments a woman social worker, "primarily because it does not affect men so seriously. Men only have to lower their pants and squat to ease themselves irrespective of time and place."

Today, Gandhian workers form the backbone of the few voluntary organisations that are working in the field of sanitation. Their motivation is a concern for the "bhangis" or scavengers, who daily go through the inhuman drudgery of cleaning latrines only to be treated as untouchables by the high-caste population. Two Gandhian organisations, Sulabh International in Bihar (see box) and the Safai Vidyalaya (School for Cleanliness) in Gujarat, have successfully shown that for most urban residents, the water seal privy is the only chance to obtain decent urban sanitation and free the bhangis from their stigma.

Sewerage systems only serve a miniscule part of the population. Yet planning centres around allocating funds for these systems instead of for the cheaper composting toilets, which at present are only a pilot project. A strong point against sewerage systems is that they pollute water sources and create stinking collections of water which breed mosquitoes. The advocacy of sewer system springs out of a blind acceptance of Western standard by engineers and planners.

URBAN TRANSPORT

Urban transport in India is a nightmare. Hopelessly overburdened public transport systems, chaotic traffic on major routes and unsafe roads are recurrent scenes. The major causes of this crisis are: the urban population boom, a rapid expansion of city limits, increased travel, the concentration of business and economic activity in central sections of cities, an overriding emphasis on motor vehicles and callous and ill-trained drivers.

Contrary to conventional wisdom, the pressure on public transport in metropolitan cities is not due to just the increase in population. Data in the Report of the National Transport Policy Committee (NTPC), 1980, shows that increases in the bus fleets of Bombay, Calcutta, Delhi, and Madras kept pace with their population growth between 1961 and 1978. At the same time, however, commuting habits changed, doubling the number of trips per capita in the same period. These factors taken together account for the overcrowding of buses in these cities.

Bombay's public transport system is regarded as the best in the country. Yet, travelling by it is a nerve-racking experience. Its buses carry more than twice their capacity. Bombay's suburban trains are bursting at their seams with almost four million passengers every day. Each local train carries over 4000 persons during peak hours as against a capacity of only 2600. A third of the trains on the Central Railway line are dilapidated and need replacement.

Obviously then, the quality of public transport in other Indian cities can only range from the unthinkable to the unbearable.

Clogged roads

Not only are the vehicles in Indian cities crowded, but the roads on which they ply are also clogged during peak hours. In most major cities, business and economic activities are concentrated in central areas while residences are increasingly located in farflung suburbs or colonies. As cities expand, average trip lengths increase.

The congestion worsens as a result of increasing density of people and vehicles on the roads. Between 1961 and 1978, motor vehicular traffic increased several fold in the metropolitan cities. The number of cars has continued to increase despite the massive escalation in oil prices. Adding to the mayhem are the intermediate public transport modes like mini-buses, taxis, motorcycles, scooter rickshaws, cycle-rickshaws and tongas.

During peak hours, all movement in the central areas seems to be pointed in one direction. Vehicular speeds reduce to a crawl. The average road speed in central city areas levels off at 10 to 16 km per hour. Forty years ago, a horse buggy in Bombay could cover the distance between Opera House and Flora Fountain in 10 minutes and 30 seconds. Today, "an automobile takes three times as long," writes Chandrakant Tamanhe, an editor with the "Maharashtra Times".

Rising urban incomes and the failure of public transport to keep pace with city needs has resulted in a stampede for private vehicles. Between 1961 and 1978 the number of cars, including jeeps and station wagons, shot up by 244 per cent in Bombay and 560 per cent in Delhi. The corresponding increase in the number of buses was 158 per cent in Bombay and 380 per cent in Delhi.

Motor vehicles consume substantial amounts of energy and generate atmospheric pollutants. They cause noise and vibration. And worst of all, they increase the risk of death in road accidents. The increasing emphasis on motor transport, particularly on privately-owned vehicles in metropolitan cities, is an environmentally retrograde trend. It goes against the current trends in the environmentally conscious cities in the developed nations. In 1957, bicycle rides accounted for 36 per cent of all the trips in Delhi. In 1981, the number had fallen to 20 per cent. Bicycles can be made an attractive alternative to motor vehicles, especially in medium and small towns, with proper planning (see box).

The critical problems in most small and medium size cities are "inadequate, poorly designed and outdated road systems and overcrowded transport systems," states a report prepared by the Indian Institute of Management in Ahmedabad.

Ad hoc development

"In a way these cities are placed in a worse situation because at present no attention whatsoever is being paid to even identifying their transportation problems and conditions are fast deteriorating day by day. Whatever infrastructural development is made, it is haphazard, ad hoc and unrelated to traffic requirements assessed on any scientific basis," says the NTPC report. "There is no organised public transport system in these cities."

Distances in large towns are too long to be traversed by walking. Though buses are the preferred mode of transport, next only to walking and cycling, they form a minor part of the traffic network in these cities. As a result, the well-to-do rely on private vehicles like cars, scooters and motor cycles or on hired means like cycle or auto-rickshwas, tongas or tempos (a three-wheeled taxi). But these are beyond the reach of the daily commuters and ordinary citizens. They are

Table 3. Growth of motor vehicles in four metropolitan cities

Type of registered vehicles	Calcutta		Bombay		Delhi		Madras	
	1971	1978	1971	1978	1971	1978	1971	1978
1. Car/jeep/ station wagons	54,738	80,804	98,171	137,407	61,521	105,204	24,454	27,795
2. Motor cycles/scooters (two wheelers)	15,589	33,917	32,555	62,687	109,112	282,338	14,243	40,765
3. Auto-rickshaws (three wheelers)	—	—	6	667	10,812	17,890	393	1518
4. Taxis	6299	7089	16,017	23,703	4105	5580	3671	2496
5. Buses (standard/ school/mini)	3205	4473	3174	3454	3266	6929	2265	1819
6. Trucks (private/public/ carriers, tractors/trailers, tempos/ (delivery vans)	20,655	25,792	27,492	35,496	15,262	31,112	3471	5378
TOTAL	100,486	152,075	177,415	265,414	204,078	449,053	48,497	79,771

Source: Report of the National Policy Committee, Planning Commission, New Delhi, 1980.

thus forced to herd into ramshackle buses, like cattle. "The average cost of travel per passenger km in medium size cities is four to five times the travel cost in metropolitan cities due to a lack of organised mass transportation system," estimates the NTPC.

As these cities expand, longer distances will create a higher demand for buses. Presently, bus services are generally unprofitable and neglected.

Road safety

Indian roads are among the most unsafe in the world. Reckless driving, in total disregard of all regulations, and faulty traffic planning cause almost 20,000 deaths every year (these are official statistics, actual figures may be higher), about eight per cent of the world total.

The NTPC has estimated that road accidents in eight cities — Delhi, Bombay, Calcutta, Madras, Hyderabad, Bangalore, Pune and Chandigarh — together, account for over 30 per cent of the road accidents in the country. Delhi has the highest rate of road accidents in the world, 75.5 per 10,000 vehicles in 1980, according to Prof A.K. Banerjee of the All India Institute of Medical Sciences. Worse still, claims Prof Banerjee, its vehicles are also the deadliest in the world with 12.5 deaths per 10,000 vehicles as compared with 1.7 for Washington DC, and 2.7 for Los Angeles.

Pedestrians and cyclists are the worst hit. In 1980, out of 663 persons who died on Delhi's roads, 246 were pedestrians and 137 were cyclists. The NTPC report says, "Pedestrians are perhaps the most neglected category of people moving on roads in Indian cities. Very few roads provide for a sidewalk or a footpath for use by pedestrians. Even where they have been provided, they are not usable due to encroachments."

More road deaths, however, take place on national highways, than in urban areas. The national average of about 57 deaths per 10,000 vehicles is almost five times the figure for Delhi and is about the highest in the world. This is probably because a significant number of accidents on intercity roads involve buses, leading to a high number of deaths per accident.

"Death due to negligent driving" has become a cruel headline that we see in the newspapers every day. Much of this can be attributed to reckless driving by bus and truck drivers. Police records analysed by Prof Banerjee showed that buses and trucks in Delhi caused 10 times as many accidents as cars. Finally, judging by newspaper reports, more accidents take place on the broad, well-lit roads in south Delhi than in the congested walled city section.

Remedial measures are urgently needed. In addition to some basic steps like tightening licensing procedures, driver education, strict enforcement of traffic regulations, etc, some really innovative thinking is needed in the design of footpaths, where people and not cars are the central consideration. Pedestrian malls in central city areas, where only essential traffic is allowed, is another idea whose time has come.

Citizen initiatives

A heartening feature on the urban scene is the emergence of voluntary organisations and individuals committed to the improvement of living conditions in the cities. The most numerous and well-known are in Bombay. The Save Bombay Committee, Society for a Clean Environment (SOCLEEN), the Bombay Environmental Action Group and its constituents like the Bombay Civic Trust, have led numerous mobilisation and educational campaigns against noise, air and water pollution. Civil liberties organisations and social activists have taken up legal cudgels against evictions of slum dwellers in Bombay.

Kalpavriksha, an organisation of students, some still in school, has led campaigns against tree cutting along Delhi's boulevards. It has also started environmental education programmes among school students. Forest Lovers' Action Group (FLAG) is another organisation in Delhi with aims similar to those of Kalpavriksha.

In Ahmedabad, the Ahmedabad Study Action Group (ASAG) has done pioneering work in housing for the poor. Vikas, a newer entrant, is active in slums inhabited by nomadic tribes. The Vikram Sarabhai Centre for Development Interaction (VIKSAT) focusses its efforts on fostering

Calcutta's Howrah bridge is a looming presence over the chaotic traffic scene. Traffic signals and rules are observed only in their violation, and a variety of vehicles adds to the mayhem on Indian roads. (S.K. Dutt)

Bus drivers and conductors are often reluctant to stop crowded buses at appointed stops. This generally sets off a mad dash, with caution thrown to the winds by anxious travellers. (WHO)

Wheels of the future

India's urban transport system is ecologically more diverse than that of any other country in the world. It is an amazing assortment of electric trains, buses, cars, taxis, three-wheeled auto rickshaws, scooters, motor cycles, tongas (horse carriages), bullock carts and bicycles. It meets the needs of almost all income groups.

As a form of personal transport, however, the bicycle continues to reign supreme within this mass of contraptions. India produces more bicycles in one year—4.16 million in 1980—than all the motor cars that are registered in the country. Nearly every fourth household in the country possesses a bicycle. In cities like Delhi, Bangalore, Hyderabad and Pune, the cycle traffic constitutes about 60 to 75 per cent of the total vehicular traffic.

With fuel and vehicular costs rising rapidly, the bicycle appears to be more a vehicle of the future than the past. Motorised vehicles are becoming increasingly expensive even for the middle classes. By the end of the 1970s, the sales of the moped, for instance, had been increasing faster than sales of even scooters and motor cycles. Moped sales doubled in just two years between 1978 and 1980.

In these circumstances, it is amazing that bicycles are such a neglected form of transport in urban planning. "Out of the 14,316 km of Delhi roads, only 25 km are cycle tracks," says Dr A.N. Bansal of the National Council of Applied Economic Research.

This is not just a question of bicycle tracks. In fact, the basic urban form of our cities and towns would have to change if our urban planners were to plan the growth of our cities around bicycles. "Tell me what transport you are going to permit and I will tell you what your city will look like," says a leading urban planner from abroad.

The chaos in urban transport today is essentially because our urban planners are trying to impose a "car city" on an economy which can at best support good "bike cities". In the process, our cities are becoming more of a nightmare for cyclists with every passing year.

Unlike the Western countries, the fringes of our cities are occupied by the poor and not the suburban rich. With employment opportunities remaining concentrated in central areas, trip lengths are increasing as residential accommodation keeps on spreading to the periphery, which itself drifts further away from the core as the city expands. As a result, while poor people in Delhi bike to work every day from far across the Yamuna, the rich who own cars or get government cars, live right next to their work places.

If cities were to be planned as bike cities, then a cluster approach with residential spaces around work, commercial and residential centres would be more appropriate. Urban transport problems essentially arise because of the separation of the home from the work place and by the practice of trading off higher transport costs for more work and residential space. With fuel costs rising faster than purchasing power, these trade-offs are no longer practical and if they continue to be made, will only lead to more chaos. The most unfortunate problem is the low social status attached to the bike in India.

In fact, purchasing power in India is so low that the bicycle industry is facing a sluggish home market and looking to an export market for its growth. India manufacturer fewer bicycles every year than USA produces cars. In contrast, China's egalitarian economic system has led to such a massive demand for bicycles, that it has had to place import orders on the international market to meet its domestic needs. The Chinese tender has become a major source of excitement for the bicycle industry in India. The bicycle technology revolution currently taking place in the West—a man even flew in a bike-powered plane recently—is certain to pass us by because of the low purchasing power in the country. These technological developments will make the bike an efficient and fast vehicle but it will also make it more expensive. The Indian bicycle industry is, therefore, least interested in these technological developments.

The neglect of bicycles in road planning is also leading to unnecessary deaths. Nearly 15-30 per cent of road accident deaths in India are of cyclists.

The current trend of replacing the older forms of transport with motorised ones which only a few can afford is being followed even by the Marxist Government of West Bengal. The State Government has pushed through a Bill—still awaiting the assent of the Governor—which makes all the unlicensed hand rickshaws of Calcutta illegal. The British had set an arbitrary, limit of 6000 in 1939 for licensing hand rickshaws, as a result of which 90 per cent of the rickshaws plying the roads of Calcutta are today unlicensed. When the petty earnings of all these rickshaws are added up they amount to some Rs 50 crores every year and these earnings support about 0.2 million families spread as far as Bihar and Orissa.

Unnayan, a voluntary group in Calcutta, argues strongly against the official contention that hand rickshaws are guilty of traffic congestion. On the contrary, they can pick people up from the narrow lanes and carry them to the hospital, which buses cannot do. They are certainly not guilty of bad driving, especially when compared to unruly buses. In any case, at a time when the city's mass transport system is overloaded, it would be wrong to weed out such an important component of the city's transport system, apart from the equally relevent questions of social justice.

environmental awareness and community participation.

The Madras Environmental Group (MEG) was started last year, largely by professionals concerned by the rapid degradation of the city. The Centre for Legal Action (CAL) brings together lawyers and concerned citizens for public interest litigation. Aranyam and the Madras Naturalist Society are also well-known for espousing environmental protection.

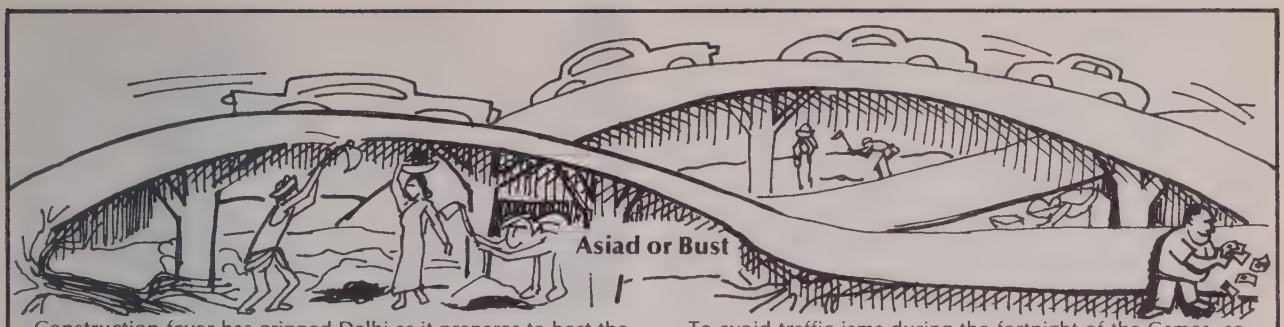
Unnayan, an urban development organisation in Calcutta, emphasises community involvement in its programmes. In the past it has done work on low cost housing. Currently it is helping rickshaw pullers improve their pedal rickshaws.

Despite intense efforts by the workers of all these organisations, their impact is still peripheral.

What can citizens do when a municipality refuses to fulfil its statutory responsibilities such as providing clean drinking water or providing proper drainage? They could "use the law and call the bluff of the municipal body's bovine indifference to its basic obligations," pointed out Justice V.R. Krishna Iyer of the Supreme Court. Justice Iyer was delivering a precedent-setting judgment in a suit filed by the citizens of Ratlam against its Municipal Council.

The citizens of Ward 12 in Ratlam had successfully moved a local trial court to direct the Municipal Council under a provision of the Madhya Pradesh Municipalities Act 1961, to construct proper drainage for the locality. When the State High Court affirmed the trial court's order, the Municipal Council approached the Supreme Court. It pleaded that financial inability exonerated it from fulfilling its statutory obligations. Justice Iyer turned down the plea and directed the Council to carry out the work within a specified period or face the penalty of law.

Justice Iyer's judgment has spurred a new interest in public interest litigation on environmental issues. In the last year, citizens have filed similar suits against the civic bodies of Bangalore, Delhi and Madras. Yet in most public interest litigations, the recourse to courts appears to have been the last resort. This reflects a lack of trust in the ability of the legislative and political processes to resolve the citizens' problems.



Asiad or Bust

Construction fever has gripped Delhi as it prepares to host the Ninth Asian Games. Government-sponsored advertisements in newspapers and magazines across the country boast about the international recognition that will come to Delhi. Unfortunately, in the euphoria over national prestige, the negative environmental and socio-economic repercussions of the Games have been ignored.

Preparations for the Asian Games have left Delhi scarred with large stadia and flyovers and robbed it of valuable tree cover. The authorities have tended to underplay the environmental damage. Kalpavriksha, a local environmental organisation, has charged Delhi's Lieutenant Governor S.L. Khurana with misrepresenting the number of trees cut down to widen roads for the Games-generated traffic. "Last year Mr. Khurana had told newspapers that only 57 trees had been cut. This April he admitted that the actual number was 1342," says Kalpavriksha. In recompense, the Delhi Administration has announced plans to plant 3000 trees — but not along the roads. They will be located in groves near the Games' sites.

The ridge, a stretch of scrub forest covering 46000 acres, has been invaded to provide for smooth flow of vehicular traffic. The encroachment of the ridge violates the recommendation of Delhi's Master Plan that it be preserved as close to an undisturbed forest as possible.

The Siri forest in south Delhi once abounded in birds and small animals. It has been reduced to a few apologetic pockets of greenery surrounded by the concrete structures of the Asiad village. Delhi already has one of the highest dust levels in the world. Increased construction and destruction of green areas will exacerbate this problem.

To avoid traffic jams during the fortnight of the Games, seven massive flyovers have been constructed. All of them are in New Delhi which already has wide roads. The daily needs of the clogged narrow roads in old Delhi remain forgotten.

The costs of the Games are a subject of controversy. The Special Organising Committee of the Games gives a figure of Rs 70 crores. That, however, is only an estimate of the costs of the sports facilities and the organising expenses. Last year in Parliament, the Minister for Planning said that the total estimated expenditure for the Games (and the infrastructure) was Rs 361.20 crores. Opposition politicians allege that the actual figure will be about Rs 1000 crores. Where will all this money come from? Obviously, some development programmes will suffer (see table).

For instance, the Government has shelved urgently needed schemes relating to Delhi's water supply and drainage due to "lack of resources." The Rs 46.60 crores urban sewage scheme, which is essential for the health of the citizens, has been postponed indefinitely.

Migrant construction labourers are working round the clock in terrible conditions. They live in miserable slums with hardly any amenities for clean drinking water and sanitation. A few have died in accidents at the work sites. So far, Delhi's citizens have been apathetic to the environmental changes caused by the construction frenzy for the Asiad. New Delhi's administrators are preparing to bid for hosting the Olympic Games in 1992. Perhaps the Department of Environment will carry out an environmental impact assessment for the Olympics as it did not for the Asiad.

COST	ASIAN GAMES	VS	ENVIRONMENT
Rs 3610 million	Expenses on Games-related projects as stated by the Minister for Planning in Parliament		Capital cost of four 200 MW thermal power plants capable of providing twice the demand for domestic power in Delhi
Rs 700 million	Special Organising Committee's (SOC) estimate of costs of sports facilities and organising expenses.		Cost of fourteen 500-bed hospitals.
Rs 500 million	Approximate cost of the seven flyovers for the Asian Games		Cost of urban sewage scheme for Delhi which has been postponed indefinitely.
Rs 250 million	Approximate estimate (SOC) of the cost of indoor stadium and swimming pool		Cost of 2500 buses which can easily meet the transport needs of Delhi.
Rs 160 million	Approximate cost (SOC) of the main stadium		Four times the cost of electrifying the resettlement colonies of Delhi.

RURAL HABITAT

According to the 1981 census, well over 500 million people — that is, about a tenth of the world's population — live in India's villages. The population growth rate of rural areas from 1971-81 was much lower than that of urban areas. While the number of people in India's towns and cities increased in this period by half, the rural population did not increase even by a fifth. But because of the magnitude of the problems posed by the rural areas — 76 per cent of the country's population is rural — and the limited funds allocated to their development, problems like housing, water supply and sanitation have continued to grow.

A substantial proportion of the rural population lives in small settlements of less than 500 people, therefore it is difficult for a centralised bureaucracy to provide and maintain these amenities. Government services have never found it easy to mobilise the rural people to organise their own material and manpower resources either.

The continuance of mass poverty has meant that the rural people are not in a position to purchase these amenities. In 1977-78, as estimated 47.85 per cent of the rural population could not earn even Rs 742 per year, which puts it below the poverty line.

RURAL HOUSING

Housing conditions in rural India are indeed appalling. A survey conducted by the Institute of Development Studies in Mysore during the mid-'70s showed that in many Indian villages nearly half the existing houses needed urgent repairs. Many houses built of traditional materials like mud and thatch had been standing for more than 50 years. In some cases even the straw matting on the roof had been replaced only once or twice in this period. The proportion of houses that met the minimum standard in the rural housing stock was low and they were invariably the residences of the rich landlords and other prosperous local people.

The bulk of the rural people live in extremely bad conditions, under leaky, makeshift wormy roofs, huddled on small lots at the mercy of village landlords. "It is not easy to visualise how these people can be housed," admits a senior scientist at the Central Building Research Institute. According to an estimate prepared by the institute in 1977, 12.1 million new houses were needed to meet housing needs in rural areas in that year. Assuming a low average cost of Rs 3000 for a rural house, the financial requirement of Rs 3630 crores constitutes a substantial sum for the Government to provide, over 10 times the expenditure budgeted for rural housing during the Sixth Five Year Plan. India's planners frankly admit that the country's housing problems — both rural and urban — cannot be solved in the foreseeable future.

Severe restraints

The housing requirements of the country can be met only through a sustained programme of investment and construction over the next 20 years. The Sixth Five Year Plan document, however, admits that the role of government in the field of housing, especially rural housing, has been limited because of severe restraints on public resources

A cluster of houses in a north Indian village, built with traditional materials like mud and thatch. (Mukul Dube)

During the Fifth Plan (1974-79) the Government did take some serious interest in rural housing problems. The plan began by providing house sites to rural landless families. Under the minimum needs programme a high priority has been placed on the provision of house sites and assistance for construction of houses for rural landless workers. The planners estimate that the number of families needing house assistance will be around 14.5 million by March 1985.

By the start of the Sixth Plan, 7.7 million sites had already been distributed to the rural landless, leaving another 6.8 million families still to be provided with house sites. Of the families provided sites, only about 0.56 million have so far received assistance for constructing houses. Therefore, about 13.9 million families still need housing construction assistance.

The Sixth Plan has proposed that by the end of the plan period, sites should have been provided to all landless families in the country; about 25 per cent of the eligible families, that is, about 3.65 million families, should also be provided assistance for construction during 1985. The plan recommends that the Government should aim to provide housing assistance to all landless labour households by 1990. Apart from the provision of housing sites, this assistance would include locally available construction materials, a masonry tubewell for each cluster of 30-40 families and an approach road. All labour inputs would be provided by the beneficiaries. The Sixth Plan has made a provision of Rs 250 per family for developing sites and Rs 500 per family for construction assistance. The total plan allocation thus touches about Rs 354 crores.

To implement this programme, the planners themselves point out that organisations will have to be set up at all tehsil, taluka and block levels for the disbursement of the housing subsidy to the eligible families. These organisations will also have to assist the rural landless families in developing layouts and housing plans for these clusters of houses such that appropriate access, as well as drainage, the lack of which constitutes a health hazard during the monsoon months, is available for these sites. Locally available materials like roof tiles and drain tiles would have to be obtained from local potteries. The planners also recommend that the beneficiaries should be involved in the design of their houses.

Given the sloth with which centralised bureaucracies move and the opposition that this programme faces from the prosperous sections of rural society, these plans cannot be achieved easily. With the number of landless families growing rapidly on one hand and the vegetative cover rapidly diminishing on the other, landless families have great difficulties obtaining even traditional building materials like mud, thatch, timber and bamboo. Mud can only be taken with the permission of the landlord and timber is extremely scarce and expensive. People now have problems finding these traditional materials even near forested areas because forests have been reserved and their use mainly directed towards distant urban markets.

Bamboo

Take the case of bamboo, for instance. All along the Western Ghats, villagers have traditionally used bamboo to build their own houses. Split bamboo strips and mats are used to make the walls; bigger bamboos serve as pillars and beams for the roof; and, bamboo mats form doors and windows. When bamboo was abundantly available, a bamboo hut could be built quickly, and with little effort.

Bamboo was abundant on the Western Ghats till it became the raw material for the paper industry. The current estimates for Karnataka, for instance, are that the annual increment of bamboo stocks is 135,000 tonnes, while the annual harvest is 160,000 tonnes. Something like 80 per cent of this harvest is for the paper mills. Bamboo has now been wiped out over large areas.

Bamboo which was earlier available essentially as a free commodity to villagers, enabling them to construct houses almost free of cost, now costs them Rs 1200 a tonne. At the same time the paper industry, which is primarily responsible for the destruction of the bamboo stocks, continues to pay a concessional price of Rs 15 per tonne.

Only Karnataka and Kerala have made serious efforts to launch major rural housing programmes but in neither have the programmes been successful in reaching out to the majority of the rural population.

Mahatma Gandhi once remarked: "What India needs is not mass production, but production by the masses." This can be easily paraphrased in the housing context to: "What India needs is not mass housing but housing by the masses." This obviously means building with traditional building materials.

Mud houses

Though the Sixth Plan document mentions the need for intensified research on cheap and locally available building materials and paying attention to the importance of energy conservation by using these materials, planners and architects generally refuse to look at them. Mud, for instance, is one of the most widely used building materials in India; probably more than half the houses in India are made from mud. Even in urban areas mud is often used by slum dwellers to build their shelters. But mud is looked upon with contempt by planners, architects and civil engineers. It is considered unsafe, unhealthy and impermanent. As a result, government housing programmes only think in terms of brick and cement.

Indian researchers have never made serious efforts to devise improved mud building techniques, even though it is unimaginable that bricks and cement will be able to satisfy India's housing needs well into the 21st century. Cement is today so scarce that it is a major source of black money and political corruption. In many ways cement is similar to electricity; its use is concentrated in the towns and among the rich. Moreover, both cement and bricks are extremely energy-intensive materials. Nearly half the cost of producing cement and much more than half the cost of producing bricks is the cost of energy. About 20 million tonnes of firewood are estimated to be used every year for burning bricks and by household industries, adding to the problem of deforestation. With the price of energy sources rising rapidly, the cost of modern building materials is certain to rise faster than the purchasing power of the people, making it even more difficult for the poor majority to acquire modern housing.

The widespread adoption of brick and cement houses by the rich has created a value system which has made even the poor lose interest in living in improved mud houses. An inmate of Aurobindo Ashram, who recently built an entire village using the rammed earth technique near Pondicherry, found much to his dismay that the beneficiaries of this programme did not care much for their new houses (see box). A house built of mud, however much improved, still smacked of poverty and squalor. People who can afford better houses almost certainly think of a structure built of cement and bricks.

Short-cuts

As the cost of this is prohibitive even for the majority of prosperous villagers, many of them economise by degrading construction specifications. A mortar will be used containing too little cement. The breadth of the foundation and the thickness of the wall will be reduced.

A survey by the Planning Research and Action Institute (PRAI) at Lucknow found this is a widespread practice in village houses. The walls and roofs of many such cheap pucca houses crack within a few years and the floors and plaster start to wear away. Houses begin looking shabby in just three to five years. As the walls are too thin, the house is uncomfortably hot in summer and cold in winter making the use of fans and heaters essential.

As only such economising can put pucca houses within

A beautiful tribal hut in Dang district, South Gujarat, built with split bamboo strips and mats. With bamboo becoming scarce, such sights will soon become rare. (Smitu Kothari)

Who wants a thousand rupee house?

It is "no-cost"—not "low cost"—housing that the majority of the people in this country can afford, says Devendra Kumar, director of the Centre of Science for Villages in Wardha. This inevitably means building with local materials.

The hopes of the young German architect, Reinhold Pingle—an inmate of the Aurobindo Ashram at Pondicherry—have been dashed, however, by the response he has received from the villagers. He helped them to build a brand new village near the Ashram using an improved mud building technique but the villagers hardly take care of their homes. Improved or not, mud is a low status material to them. The rich do not—and will not—live in mud houses.

The new village does not inspire any sense of prestige amongst its inhabitants even though bricks and cement are so expensive that at best they could afford only small, standardised, concrete containers as dwellings.

Pingle, fondly known as Popposwamy amongst the villagers, used a new building technique of ramming earth adopted from the Berber tribe of Morocco. This technique has also been practised in India, but only in the northern hill tracts of Ladakh and Himachal Pradesh. In this technique, mud is packed between two boards and then rammed to form a solid wall.

Structurally, well-made mud buildings are reasonably stable Their only problem is rain. The overhanging roof of palmyra and thatch is provided by Poppo to protect the earthen wall against driving rain. The wall base is also given a sloped packing to strengthen it against erosion from running surface rainwater.

Poppo has been trying to give practical shape to the concept of a "thousand rupee house" for the rural poor. Holding costs down to the one thousand rupee mark is becoming extremely difficult after the spiralling price hikes of the mid-'70s. The rammed earth technique is one alternative.

After the 1977 cyclone which ravaged parts of Andhra Pradesh and Tamil Nadu, Poppo was asked to build a new village for disaster victims. A row of 50 houses of rammed earth came up in Mahaveerpuram which previously housed a few dilapidated mud shacks. Each house cost the sponsoring relief agencies about Rs 1300.

The costs could have been even lower but the workers (who were to occupy the houses subsequently) never bothered about restraining the costs because it was not their own money. They were always looking out for more wages, less work, and were wasteful with materials.

The experimental aspect of the houses was of no particular interest to these owners. In fact, these mud houses created considerable disillusionment among them because they had expected concrete houses.

This experiment with mud buildings has cost Poppo 10 years of sweat and toil; and he has mellowed down considerably. "I have learnt that housing cannot be imposed on the people, it has to evolve on its own. Housing is not a product but a process which grows with the needs of the people."

RHEINHOLD PINGLE

the reach of villagers, these houses are still being built in large numbers especially in the green revolution areas where agricultural incomes have been rising steadily amongst the landholding classes. The Government is constantly urged to improve the standard of its low-cost houses, which will mean inevitably that the beneficiaries will be from the richer sections. Instead of asking for better designed houses using traditional materials, a recent report of a parliamentary committee investigating the programmes of the Housing and Urban Development Corporation (HUDCO) points out that many States find its ceiling of Rs 4000 for the construction of a rural house too low and therefore it needs to be reviewed.

Environmental context

It is also amazing that hardly any architect has cared to analyse the environmental context of the so-called modern construction techniques and housing styles. Houses with courtyards, for instance, are disappearing all over India specially in urban areas and slowly even in rural areas. Courtyards ensured a good flow of air through the house and kept it cool during the summer. The new houses are extemely hot in summer and cold in winter, totally unfit for the climate of tropical countries. This results in an artificial and unnecessary demand for electrical products like fans, airconditioners and coolers.

A leading Hindi newspaper recently lamented that modern housing, like modern clothing, has become a matter of fashion: "It is only in the matter of food that we still retain our Indianness. How can cement be strengthened by steel is a subject on which our civil engineers read whole treatises. But how can mud walls be strengthened by bamboo is a subject that only ..... villagers know ..... If eskimos of the Arctic tundra can make houses of ice which suit them and keep them warm, why can't we make houses which suit our environment?"

The only answer can be: a blind belief in Western techniques and lifestyles and a callous neglect of the living conditions of the majority of our people.

RURAL WATER SUPPLY

In 1979, India suffered what was probably its worst drought of the century. For many villages which are short of drinking water this meant enormous difficulty. Wells, tanks and various other sources of water supply dried up in large numbers. The drought forced women to trudge even further than usual looking for water. "Young men in drought-hit villages of Madhya Pradesh", reported a news item," are apparently having a tough time finding a bride. This is the result of parents being unwilling to marry off their daughters for fear that they might be asked to walk long distances to fetch water. The problem is being described as 'drought-affected marriages'."

In February 1980, the Commissioner of Scheduled Castes and Scheduled Tribes drew attention to another well-known problem: the lack of access to safe drinking water amongst rural harijans. High caste villagers often do not permit them to use the village wells. The harijans are then forced to travel far to get their water or must turn to polluted sources that the higher castes do not use.

Despite all government efforts, nearly 70 per cent of the

country's rural population remains without safe drinking water supplies. There are about 200,000 villages with a population of about 160 million people which have to be provided potable water supply facilities on a priority basis.

Though the Government of India is committed to the International Drinking Water Supply and Sanitation Decade, whose objective is to cover the entire rural population by 1990 with safe water supply, the Government itself has not made any statement on when this target will be achieved.

The Government began emphasising rural water supply programmes with the Fourth Five Year Plan. By the end of 1979-80, State governments claimed that about 1.84 lakh villagers had benefited from water supply schemes of one type or another.

In 1971-72, a total of 153,000 villages in the country were identified as problem villages. Of these, 90,000 villages were classified as scarcity and difficult villages (that is those villages which do not have an assured supply of drinking water within a reasonable distance of 1.6 km) and 60,000 as health problem villages, that is, those villages which are endemic to diseases like cholera, guinea worm, etc, or those where the available water has an excess of salinity, iron, fluorides or other toxic elements. In addition, it was estimated that there were 185,000 villages with a population of 160 million which were served by wells.

Since 1972-73, 95,000 problem villages have been provided with safe drinking water supply facilities. Thus some 57,000 problem villages still remain to be served. However, various State governments have recently reported that the earlier survey did not represent adequately the magnitude of the problem partly because it was not complete and partly because drought conditions in subsequent years have revealed fresh areas which are vulnerable to water scarcity. Latest data received from State governments shows that there are at present about 190,000, problem villages.

In fact, the problem may be affecting even more villages and growing with time. There are several reports of rapidly deteriorating surface water sources because of industrial pollution. Several tragic cases of contamination of village water sources by industrial concerns have been reported by the press in recent years.

Government plans

During the Sixth Five Year Plan, the Government intends to cover all the 190,000 problem villages of the country. A total sum of Rs 2135 crores has been allocated for rural water supply in the plan; this is considerably higher than the outlay of Rs 429 crores in the Fifth Plan. The approach will be to provide at least one source of drinking water in every problem village. However, the Government will not be able to reach difficult areas in the hill and desert regions where the programme may take a longer time. The planners have also called for special attention to be paid to the location of safe drinking water points so that scheduled castes and other weaker sections of society can benefit fully. A recent evaluation by the Planning Commission shows that in the past these communities have not gained proportionately from water supply facilities created under the minimum needs programme.

Different State governments have set varying standards and hence the average cost per village for providing safe drinking water differs widely according to the type of facility provided such as hand pumps, wells or piped water supply. In Karnataka, for example, it is Rs 1600, while in Nagaland it is Rs 2.16 lakhs. In Punjab where only piped water supply schemes are being implemented, it is Rs 4.26 lakhs.

It is important that the limited funds available are used judiciously otherwise they will be inadequate even for the Government's limited objectives. The "Economic Times" recently reported the results of a survey of rural water supply schemes in Punjab. Out of 250 schemes taken up under the minimum needs programme, only 65 had been completed according to schedule. Thirty one schemes were completed with a delay of 5-10 years and 75 with a delay of 2-5 years. Misappropriation of cash, theft of materials and inadequate preliminary investigations leading to abandonment of many projects after the substantial amount of funds had been spent on them, were found to be common problems.

Poor maintenance

Poor maintenance of existing water supply systems in the rural areas continues to be a source of concern in most States. Lack of involvement of the local community, shortage of staff and inadequate funds for maintenance are among the reasons cited by the Planning Commission why existing water supply schemes have failed to yield the expected benefits. A 1976 evaluation in India concluded that nearly 70 per cent of the hand pumps were not functioning at a given time. The Government is now clear that the operation of small rural water supply systems can be ensured only with the involvement of the village community and institutions. No government is capable of maintaining free a nationwide water supply system.

A three-tier maintenance set up has been successfully tried in Tamil Nadu and has been adopted in other States with variations.

The bottom tier in Tamil Nadu is an unpaid village volunteer trained in minor preventive maintenance. He checks the pump each week, and examines all the external nuts, bolts and working parts. If something is loose, shaky, or crooked, he knows enough to repair the pump. Whenever a major job is required on the pump, he sends a post card to the second tier: a mechanic situated at the headquarters of the development block. The block team is supported by a third tier: a well-equipped team operating at the district level. The annual cost of the three-tier maintenance system has been estimated at about Rs 1.52 lakhs for 500 pumps.

The success of the three-tier programme lies in a combination of community participation and good technology. The tough India Mark II hand pump has greatly reduced maintenance needs. It is replacing the old cast-iron pumps which cannot survive the tough treatment of non-stop use by hundreds of villagers.

Who benefits?

Many experts do not believe that a populist programme like clean water for all which attracts politicians, UN experts, international consultants, water engineers and liberal do-gooders is relevant.

It is debatable whether providing water is a purely technocratic problem in total isolation from the rest of the process of economic and social development. A clear identification of communities in which clean water is a felt need is probably more important. Rural communities can be clas-

The common tap has replaced the village well. Over forty vessels are collected around this water post in a south Indian village. Women and children bear the drudgery of meeting the family's water needs. (Indian Express)

sified into two groups. The first group is of villages which do not have access to water all the year round and where women have to walk 8-16 km to fetch water. The benefits of water supply in such villages will be measured by reduced daily drudgery not necessarily by improved health. Such villagers usually participate more easily in constructing and maintaining water supply systems.

In the second group are the vast majority of villages which have a reasonable access to water all year: in the wet season, from a nearby stream or pond; in the dry season, from a well. This water is usually contaminated by WHO standards, but these water sources have been used for centuries. There is usually no real demand for safer water supply in these villages. When international agencies or Indian officials put in a hand pump, the villagers are rarely asked or involved. When the hand pump fails, the villagers go back to their traditional water sources. If they had been asked to decide how the available funds should be spent, they would probably have chosen other development priorities like water for irrigation before supply of clean drinking.

RURAL SANITATION

If providing rural water supply is proving difficult, rural sanitation is an almost intractable problem. In the last two decades the Indian Government has almost abandoned rural sanitation programmes. India's First Plan in 1952 allocated 83 per cent of the budget for rural water supply and sanitation to rural latrines alone. But by the Third Plan, disenchantment with the results had become so great that nearly all of the rural allocation was being spent on water supply alone.

No proper survey on rural sanitation facilities has been conducted. Government estimates show that only about two per cent of the rural population is covered with adequate sanitary facilities. Some observers believe that in reality this figure may be even less than one per cent. Recognising the difficulties involved in rural sanitation programmes, the Sixth Plan document points out that only about 25 per cent of the rural population can be covered with adequate sanitary facilities by 1990 compared to the 100 per cent target of the UN. Even this target appears to be high given past performance. The planners admit that more can be done in this area only through large scale mobilisation of voluntary efforts at the village level.

Efforts during the Sixth Plan period will be restricted to

undertaking pilot projects in all States which would help to assess community attitudes to the type of latrines to be provided and the nature of sanitation facilities needed

A low priority

There are several reasons why villagers do not give high priority to rural sanitation. In their view, health and wealth tend to go together: those who have land are generally healthier. It is difficult for them to suddenly accept that simply by using a latrine they will become healthier. This instinctive rejection of sanitation is probably even scientifically justified at the individual level. Environmental sanitation efforts must be adopted by the entire family and community to be effective. If one household uses a latrine, that family's health is unlikely to improve dramatically in isolation.

With the failure of rural sanitation programmes in general, rural sanitation workers in many projects effectively abandoned their efforts to persuade lower economic groups and concentrated on the richer families instead.

Sociological dimension

There is another little understood sociological dimension of rural sanitation programmes: their failure may have much to do with male domination in our society. Indian society places strong restrictions on the defecation behaviour of women rather than that of men. In most villages women who do not have a household latrine, usually go out into the fields to defecate when they cannot be seen: before dawn, that is, before the men get up, or after dark.

Studies in India and Bangladesh have shown that the few toilet systems that have been adopted by rural families in pilot programmes are mainly used by the adult women in these families. The adoption of the latrine in these households was motivated more by the value placed on privacy and seclusion for women. In villages in eastern Uttar Pradesh, for instance, it is often difficult to find a tree to hide behind for miles. As in most cases the cash investment for installing a household latrine is made by men, who do not have a major personal interest in the system, it is quite likely that they decide against it. Rural sanitation programmes targeted specifically at women have never been carried out.

Experts will have to find ways by which rural water supply programmes can be combined with sanitation and health education programmes. Although this has been pointed out by many experts, few people know how to translate this into practice.

One interesting experiment is being tried out in the Tirunelveli district of Tamil Nadu which pioneered the village hand pump caretaker scheme. In 10 blocks of the district the hand pump caretaker has also been trained to function as a health worker. He has a first aid kit to attend to minor injuries and chloroquine tablets to distribute to malaria patients; he assists in immunisation drives, tries to motivate villagers to construct manure pits and sanitary latrines and, encourages them to establish kitchen gardens. However, no evaluation of this scheme has been conducted so far.

Ultimately, sanitation and personal hygiene are matters of public attitudes. New attitudes can be created or changed only if there is a concerted drive towards them. Hardly any Indian leader considers sanitation an important public issue. The usual reaction is one of annoyance when existing insanitary conditions are pointed out. Mahatma Gandhi was a leader whose politics and behaviour were deeply rooted in Indian culture. But because he paid considerable attention to sanitation problems, unlike other Indian leaders, novelist V.S. Naipaul pronounced that he was really a "colonial" in his perspective.

PEOPLE

Mechanised trawlers are overfishing India's coastal waters and depriving the country's 6.5 million fisherfolk of an independent livelihood.

Between 1961 and 1980, the number of mechanised fishing boats increased from 2161 to 16,100 and the value of marine exports went up over 60 fold.

But in Goa, because of overfishing, the annual fish catch decreased from 40,000 tonnes in 1971 to about 27,000 tonnes in 1979.

Probably the most neglected group in India's development programmes is pastoral nomads, who comprise almost six per cent of the country's population.

The rapid conversion of pasture lands into farms has robbed them of their resource-base, greatly impoverishing them in the process. Many millions have already become landless labourers.

For India's 44 million tribals, destruction of forests has meant a cultural and social death.

With their forest-based lifestyles destroyed, the tribals are becoming human cannon fodder for the country's modernisation: poor, unskilled and viciously exploited.

7

PEOPLE

Environment is not just about land, air or water, it is ultimately all about resources. Environmental degradation is closely related to the pattern of resource-use permitted within a society. In a country like India, with a high population density and a high level of poverty, virtually every ecological niche is occupied by some occupational or cultural group for its sustenance. If that ecological niche is destroyed or its resources allocated by the more powerful in society for some other purpose, then the less powerful, dispossessed groups will obviously suffer. Increased inequality and environmental degradation are, therefore, closely linked phenomena.

In the chapter on forests, studies describing in detail the effect of the destruction of bamboo forests on basket weavers in the States of Tamil Nadu and Karnataka, who have traditionally used the bamboo resources for their sustenance, were quoted. The following sections, describe the effect of the country's forest policies on the life and culture of the tribal populations the effect of the reduction in grazing lands on the country's nomadic groups, and, the effect of the introduction of mechanised fishing vessels and trawlers on small, traditional marine fisherfolk. Like many forms of plant and animal life, each of these cultures and occupations also face a slow process of extinction because of the country's changing environment and resource-use patterns. India's unity in diversity is apparently becoming less of a reality — both the unity and the diversity — with each passing day.

MARINE FISHERFOLK

For centuries fisherfolk along India's 9040 km coastline, carefully exploited a vast ecological niche consisting of a variety of marine organisms in the inshore waters. In doing so they provided coastal and inland villages with a cheap source of protein and maintained an independent and self-sufficient lifestyle.

Today, with the entry of mechanised trawlers owned by big businessmen and multinationals in these same inshore waters, the country's 6.5 million fisherfolk, from Mandvi and Kandla in Gujarat all round to Digha and Ganga Sagar in West Bengal, are in danger of losing their livelihood. The coastal people have to pay excessively high prices for fish, and the marine ecosystem is in danger of being gravely destabilised.

The annual catch of fish, both from the Bay of Bengal and the Arabian Sea and from inland rivers and ponds is around 2.8 million tonnes. Roughly a third of this is from inland waters.

The policy of the Government has gravitated towards maximising this output and as in other development projects, scant attention has been given to integrating the fishing communities in realising this goal.

On January 15, 1977, India declared a 200 mile exclusive economic zone (EEZ) wholly in the Indian ocean, giving itself sovereign rights for exploring and exploiting the living and non-living resources of the sea. The Indian Ocean, which covers an expanse of 74.917 million square km, has an annual sustainable yield of 14.39 million tonnes of marine products. At present, the production is as litle as 2.88 million tonnes (20 per cent). Although the EEZ represents only 2.8 per cent of the total area of the Indian Ocean, 31 per cent of the potential yield is in this area.

With the declaration of the EEZ, the Government argued that this vast marine potential remained untapped owing to lack of capital and technology. An increase in global fish consumption, depleting marine resources from the habitual fishing grounds, particularly of Japan and US, and the realisation of foreign exchange from export became the three-cornered justification for introducing capital intensive technology into fishing.

Unlike some other resources, the advantage with marine systems is that they are replenished each year if given the chance to do so. Mechanisation is denying them that natural opportunity for multiplication and growth.

Indigenous technology

The fish economy, consisting of catching, marketing and consuming fish, has three technological sectors influencing it: the traditional, the modern and the ultra-modern. The traditional sector is dispersed over 1800 fishing villages along the coast and accounts for roughly 70 per cent of the total catch.

The techniques used by traditional fisherfolk gradually evolved out of a thorough understanding of the local environment. As John Kurien of the Centre for Development Studies, Trivandrum, points out:

"The professional capacity of traditional fishermen is to be marvelled at. The shark fishing of Poonthura in Kerala; the technique of paying out of the rampon (net) around an oil sardine shoal in Goa; hook and line fishing by catamaran fisherfolk in Kanyakumari..... these are indications of their mastery over a variety of techniques. Fishing for three or four days beyond land visibility at depths of 100-150 metres and returning at night to their village landing site with the aid of stars; an intelligent understanding of the influence of currents, winds and lunar forces on the movements and occurrence of fish shoals; the comprehensive knowledge of different fishing grounds, the various species of fish and their food habits—all highlight their comprehen-

Getting set to challenge the sea, fishermen launch a sparsely-equipped kattumaram somewhere on the coast of Tamil Nadu. The kattumaram craft has been adapted from the catamarans of Polynesia. (WHO)

sive scientific and intricate grasp of the totality of their ecosystem."

Even though much of their knowledge evolved indigenously, the fisherfolk were not averse to adapting and accepting designs and methods from other countries for their fishing craft. Arab influence in the construction of dugout canoes, catamarans from Polynesia, the shore seine which was first introduced by the Portuguese and the Spanish origin of the boat seine are indicative of this. Other traditional techniques like hook and line fishing present a unique case of a low-cost appropriate technology that underwent innovation and subsequent adaptation by traditional fisherfolk.

For the fisherfolk and their clientelle, which comprised the rural and lower income groups, fish was the predominant source of animal protein. Since the production activity was labour intensive and investments were minimal, with the fisherfolk collectively or individually owning all the gear, the price of fish was low and within the reach of the masses.

The life of fisherfolk has always been tough. At the root of their poverty are two factors—the marketing system which makes them victims of middlemen exploitation and lack of capital which leads to heavy indebtedness. Studies in Kerala, conducted in 1961, revealed that out of 107 fisherfolk households surveyed, only 25 had a monthly income of over Rs 100. The largest single cause of indebtedness—58 per cent of the families owed money — was from their initial investment in equipment.

Most traditional fisherfolk used boats that could not traverse the deep; fishing was restricted to the shallow inshore areas which abound in smaller species of fish. The small size of their boats, and a lack of knowledge about preservation methods, kept the size of their catch and the radius of marketing small. This low productivity also prevented depletion of resources.

The fish traders

With the development of preservation techniques like salting, drying and icing, opportunities for selling fish further afield arose. With this also came the financiers, the middlemen traders who offered facilities for preservation and marketing.

Gradually, a network was established that made these middlemen indispensable and they acquired considerable control over the trade. The Moplar traders of Kerala, for instance, went to the east and became virtual fishlords, upsetting in the process the small traders of the area. The fisherfolk of coastal Bengal used to dry a part of their catch for selling in remote districts of the Northeast. The Moplar traders initially invested heavily in setting up a complex infrastructure which included retail outlets in the Northeast. They became the principal sources of finance and eventually, a five-tier system between the consumer and the fisherfolk evolved. The fisherfolk were reduced to total dependency on this system with the sub-agents of the Moplars virtually forcing them into bondage through advances of money.

This pattern, where most of the profits were cornered by outsiders leaving the fisherfolk increasingly pauperised, repeated itself all along the coastal area. The fisherfolk continued to use their traditional methods through this period and it was at this juncture that many of the middlemen invested in mechanised boats. Modern technology conflicted with the traditional and indigenous methods, it also destabilised the economic base and lifestyle of the fisherfolk and had disastrous ecological consequences.

This characterises the situation in most parts of the country. However, there are a few exceptions as in Gujarat where a healthy and complimentary relationship evolved between the traditional and modern sectors. This was primarily because prawns were not abundant along this coast and there was a more gradual transformation from motorisation of traditional craft to introduction of trawlers.

Trawlers, export and productivity

The Government supported the move towards mechanisation. In fact, malpractices and the unscrupulous nature of the trade so far was not an autonomous development. It took root and grew with official sanction. The all-round stress on increasing production, modernisation and introduction of new types of fishing techniques developed with the assumption that the traditional fisherfolk and their technology were "primitive, ignorant, unorganised, ill-equipped and inefficient".

Fishing vessels were mechanised initially with the dual objectives of increasing the production of fish and improving the socio-economic conditions of the fisherfolk. In the

late 1950s, under the aegis of the United Nations, an attempt was made to transfer resources and knowledge to Kerala. Norway collaborated with the Indian Government to introduce motorised fishing boats and new types of nylon nets with the primary objective of improving the standard of living of the fishing community. They ruled out the possibility of an intermediate form of technology to motorise traditional canoes or catamarans.

Even though in 10 years there was a substantial increase in the number of boats and a 94 per cent increase in the catch, only a small minority of fisherfolk were able to improve their economic status. The project attempted to broaden its impact by setting up a sales organisation but all this infrastructure also raised the price of fish substantially. Coupled with this, the middlemen and large traders scuttled the functioning of this by out-buying the organisation when the catches were low and withdrawing from the market when there was a bumper catch. These were the first ominous indications of failure.

Nevertheless, the Norwegians realised that the use of the trawl net (where heavy beams are dragged on the ocean floor, scooping up all varieties of fish) was efficient for catching prawns, which were a relatively low consumption item locally. A growing demand in the US and Japan for sea food had an obvious result. Freezing plants were set up, trade contacts were established and suddenly fisheries became a sector with enormous export potential earning valuable foreign exchange.

The stage was now set for the entry of entrepreneurs and big business. Mechanisation was officially permitted to take command in a labour surplus economy and the already exploited fisherfolk, along with their investment in country-boats, nets and other equipment, were gradually left out. Between 1961 and 1980 the number of mechanised fishing boats increased from 2161 to 16,100.

Since it was productive to fish closer to the shore, the trawlers played havoc with the traditional fisherfolk whose nets were cut by the propellers and whose catches fell significantly. Added to this were the environmental implications of trawler nets which raked up the ocean floor. Not only were fish eggs and larvae breeding in the sea bed destroyed, this process also caused turbidity which fish shoals avoided, thus negatively affecting the catch of those fishing closer to the coast.

The other method adversely affecting this catch is purse-seining where mechanised boats chase a shoal, throw a drawstring net over it and lift up the catch. The net has a very fine mesh which does not allow the masses of baby fish caught to escape. (The nets used by the traditional fisherfolk are not so fine and therefore allow small fish to escape thereby not upsetting replenishment.)

Expanding exports

Between 1956 and 1976, the volume of marine exports increased 27 times, from 0.23 lakh tonnes to 6.22 lakh tonnes. The value of marine exports went up even more, from Rs 4.13 crores in 1961 to Rs 263 crores in 1979-80.

An elaborate infrastructure was created, both for the distant urban consumer and for export, but much of this new development bypassed the traditional fisherfolk. No effort was made to gradually adapt the traditional structure to the new technology in many coastal areas. Faced with displacement and deprivation, many fisherfolk became wage labourers on the trawlers.

No comprehensive studies have been undertaken to investigate the impact of mechanisation in various coastal areas. Nevertheless from occasional local studies several significant issues and trends emerge.

Researchers realise that what is important in understanding the implications of mechanisation is not only the concentration of trawlers but also the nature of the economy mechanisation represents: the procurement, processing and marketing network; its pattern, its ownership and level of investment; the pressures exerted at all points in this process which act as control mechanisms determining not only what should be available to the fisherfolk but also the prices and incomes; and the lack of concern for the ecological niche which was being exploited and destabilised in this process.

Growing conflict

There were sporadic protests within a few years of the middlemen taking increasing control over the economic lives of the fisherfolk. But these remained momentary expressions of discontent.

By the early seventies, conflict between the different sectors of the fish industry were more frequent and organised. There was a competition for space. The traditional fisherfolk used large nets which they set adrift some distance from the coast aiming to catch the larger migratory fish who dwelt nearer the surface. The trawlers on the other hand scooped up the prawns further away and in the lower levels of the sea. But the trawling action affected the traditional fisherfolk by depleting their catch as it operated in the same area of the sea. There was a competition for the same product using two different technologies. The trawler owners used the purse-seine net which involved chasing and encircling a shoal while the traditional rampon technique involved waiting for the shoal to enter the area. There was a sizeable difference in the volume of the catch between the two.

Mechanisation in Goa

Goa presents an illustrative example of the negative impact of senseless mechanisation on fisherfolk and consumers.

During the decade of mechanisation (1964-74), the number of trawlers in Goa increased from four to 200. Yet, the fish eating population was left with approximately the same quantity of fish as in 1964. The reason for this was that while the population had gone up by 20 per cent, the catch had decreased after the introduction of trawlers. Fish prices soared. With mechanised boats illegally fishing in close proximity to the shore, with the sole accent on shrimp and with the trawl net scooping up both eggs and immature female fish of other varieties, the annual fish catch decreased from 40,000 tonnes in 1971 to 26,597 tonnes in 1979. The shrimp catch, however, increased from five tonnes in 1964 to 663 tonnes in 1975. For just over 500 tonnes of shrimp for export, both the fisherfolk and the consumer suffered deprivation, unemployment, increasing poverty, high prices and protein deficiency.

By 1978, despite an investment of nearly Rs 6 crores in trawlers and the processing industry, fish for the Goan population was scarce and becoming increasingly expensive. The Goa Director of Fisheries concluded at that time: "It has also been observed that the introduction of mechanised trawlers for exploiting demersal resources (living on the bottom of the continental shelf) has not yielded a substantial increase in fish production off the Indian coast."

Gradually the market was dominated by business houses and multinational corporations; serious conflict with big business arose not from the traditional fisherfolk but from the trader and middleman. (See box). With a few exceptions, this was the trend in most coastal areas with the poor fisherfolk and wage labourers in the trawling operations not able to express their problems politically.

The Central Government constituted a committee to determine the areas of fishing for different types of boats. From the committee's recommendations, a model Bill was prepared and circulated among the States. Maharashtra, Kerala and Goa have so far enacted legislations demarcating a protected area where mechanised boats are not allowed to fish. In Goa, the Goa Marine Fisheries Regulation Act, 1981 stipulated a 5 km zone for exclusive use by traditional fisherfolk.

Yet trawlers regularly trespassed into the inshore areas. In the process, as in Goa, they destroyed the nets of the traditional fisherfolk. The All Goa Fishermen's Union alleges that in the decade of mechanisation, nets worth Rs 80 lakhs were destroyed. The catch also fell from 38,000 tonnes in 1971 to 10,700 tonnes in 1979. There have been growing protests by traditional fisherfolk, particularly in Goa and Kerala where clashes are increasing and thousands have been arrested in the past two years.

It is unfortunate that after 35 years of independence, our traditional fisherfolk have been systematically discriminated against. Besides the human cost, the marine and inland water ecosystem has been gravely destabilised. On the one hand overfishing in the coastal areas of Karnataka, Tamil Nadu and Goa has depleted fish stocks and on the other there are countless examples of serious ecological damage caused by excavation of beach sand and destruction of sand dunes by industrial effluents.

Strong representations to protect the interests of traditional fisherfolk have been made to the Central Government by National Forum for Catamaran and Countryboat Fishermen, a forum representing the various fisherfolk's unions. Action, if any, has been thwarted by the local interests against whom State governments are reticent to act.

Adequate attention has not been given to the protein needs of populations living in the coastal districts. If we make a comparison with a parallel food producing system, agriculture, we can see the vast gulf between what is provided in terms of irrigation facilities, financial support, warehousing infastructure and legislation even for the small and marginal farmer and what is provided to fisherfolk.

A reversal of policy, from one which is protecting the heavy mechanised sector to one which strives for improving the subsistence diet of poor populations, is imperative. Any programme to improve productivity must actively involve those who have intrinsic knowledge and who can protect the ecosystem. Attention should be focussed on improving the range of their countryboats, shoring up their own knowledge with scientific data from institutions like the National Institute of Oceanography (NIO), or the Fisheries Institute, setting up mini-ice plants all along the coast and providing financial credit for improving their fishing gear.

Simultaneously, heavy mechanised boats should be restricted to offshore areas where because of fluidity and natural dynamics, the water content changes and is renewed regularly. Export should be also be substantially reduced.

Marine food has become dearer for coast-dwellers: business prefers to market its catch abroad for higher profits. (SPAN/Avinash Pasricha)

NOMADIC PEOPLES

Most development strategies fail to pay adequate attention to the needs of minority and fringe groups. Perhaps the most neglected of such groups in India are those who can be termed as nomads.

True nomads are those who move round the year in a cyclical rythmic manner in a given territory, have no permanent dwellings and who practise no agriculture. The semi-nomads have permanent dwellings and may engage in agriculture or other pursuits but migrate for a part of the year.

Pastoral nomads

Structurally and functionally, Indian nomads are two types: pastoral and non-pastoral. Over 200 castes are engaged in pastoral nomadism, numbering up to six per cent of the total Indian population.

The pastoral nomads are animal herders and breeders. Their way of life is about 10,000 years old, and is widely practised in almost all parts of India, the notable exceptions being Kerala and the northeastern States.

India is unique in the world in terms of the diversity of animals associated with pastoral nomadism. There are examples of herders of camel (Rajasthan, Gujarat), donkeys (Maharashtra), yaks (Ladakh), pigs (Andhra Pradesh), sheep, goats, buffaloes, cows (in most parts of the country, especially in arid and semi-arid regions as well as in the western Himalayas), ducks (Southern India), etc. Some of the nomads maintain herds of a single animal while others

possess mixed herds. A few castes, especially shepherds, also engage in weaving.

These pastoral peoples adopt a nomadic way of life because of the non-availability of a sustained supply of fodder for their animals at a given place. Thus, they have to move continually in search of pastures for their herds. These nomads depend entirely on natural vegetation and not on planted pastures. Their contribution to the sedentary immobile society comes in the form of milk, butter, ghee, eggs, meat, hides, manure, wool, etc.

In a conference organised by the United Nations Environment Programme 1978, specialists on nomads from all over the world emphasised that pastoral nomadism is probably the most adaptive and potentially viable economic system in marginal, semi-arid and arid land ecosystems. Settled agriculture was regarded as the most destructive to these marginal environments.

Non-pastoral nomads

Hunters, trappers, fisherfolk, artisans, entertainers, dancers, singers, fortune-tellers, palmists and traditional doctors are some of the non-pastoral nomads. They comprise over 300 groups (in Maharashtra and Karnataka alone they number about 105 and 90, respectively) and constitute about one per cent of the total Indian population.

In contrast to the pastoral nomads, these nomads largely depend on the resources generated by sedentary peoples. Several of these groups also depend heavily on wild animals. (In contrast, pastoral nomads completely lack a hunting tradition).

The characteristic feature of non-pastoral nomads is that their subsistence strategies are multi-resource based. These nomads are an integral part of the social, economic and ritual network of the area in which they operate and over the years they have developed a symbiotic rather than competitive relationship with the sedentary peoples.

Nomads and development

Two major factors are responsible for the present crisis among nomads. Firstly, developmental programmes such as expansion of agriculture to marginal lands (which were earlier grazing lands available to nomads), urbanisation, industrial expansion, and destruction of the traditional land tenure systems, have drastically reduced the pasture areas available to nomads. This has made livestock production a difficult and uneconomical proposition for them. Secondly, the policy of settling these nomads by absorbing them into non-pastoral activities (such as cultivating degraded lands) has further worsened their economic condition.

These observations have been corroborated by several studies, including one conducted by the Indian Statistical Institute, of 32 nomadic groups in Maharashtra — 23 pastoral and nine non-pastoral — constituting a total population of 4.5 million. The study found that these people were becoming increasingly impoverished over the last 30 years, but the traditional relationship between them and the sedentary people had been so disrupted that now there was open conflict between them. Inequalities within each nomadic group had also assumed alarming proportions and an ever-increasing number of them were being forced to give up their traditional occupations.

In the absence of viable alternative means of subsis-

Works halts travel for a grindstone-carving family from southern Maharashtra, which has the largest number of non-pastoral nomadic groups in India. (UNICEF/Purnima Rao)

tence, many of these nomads had no choice but to become landless unskilled labourers.

The Hatkars, a pastoral sheep-rearing group, present a graphic example of this phenomenon. Numbering about six lakhs, the Hatkars are distributed over 19 districts of Maharashtra. Traditionally they only maintained sheep and were true nomads; presently they are in different stages of nomadism, the majority of them having become semi-nomads.

A survey of 538 households sampled from 16 districts shows that only 19 per cent of them are now herders of sheep and/or goats and of these, only for seven per cent this is the main occupation. Of the people surveyed, 18 per cent had become landless labourers. Over the last 20 years the herd size of most had reduced by 42 to 62 per cent. With increasing difficulties in finding pastures, they had to drift much farther from their base villages and for longer periods of time. The rates of animal mortalities have also increased substantially over the years as have conflicts over grazing lands within and between the groups.

A similar situation exists among nomads all over the country. During a recent field expedition organised by the Indian Statistical Institute of Rajasthan, Punjab and Himachal Pradesh, the Rabaris, Gaddis and the Gujjars exhibited a similar pattern of change as observed among the Hatkars. In fact, in Rajasthan, in the absence of any other alternative mode of production, a large number of Rabaris have migrated nearly permanently to Maharashtra, Madhya Pradesh and Haryana.

The natural fodder base of the nomads is getting drastically depleted. This has already affected the lives of numerous nomads, and if continued, will result in the destruction or disappearance of many pastoral (both nomadic and settled) societies, and consequently of this mode of production in environmentally marginal areas.

TRIBALS

Under the visible India of industry, commerce, science, irrigation, power projects and big government, there lies an almost parallel, in some ways a subterranean, civilisation: that of tribal India. For the mainstream Indians ecologically unsound development plans often mean just some discomfiture. For the tribals they spell a cultural and social death.

This statement is no exaggeration when one surveys the conditions of the nearly 44 million tribals living across the country. Once these "primitive" peoples, as modern parlance has dubbed them, were spread across the whole of India. Today they live in isolated clusters.

There are more than 400 groups of people who are declared as Scheduled Tribes, representing about seven per cent of the total population of India. The various tribal groups are distinct from each other in language, ethnic affinity, religion, social structures and economic conditions. For instance, while the tribes of the sub-Himalayan regions and northeast India are derived from a Mongoloid stock, the major tribes of south and central India belong to a proto-Australoid stock. The tribes of northeast India have literacy rates higher than the all-India average while tribes in the rest of the country have a much lower literacy rate.

Common features

The different tribal groups also have some common features. Most of the tribes inhabit less accessible areas which are either hilly or covered with forests, and lack a good communication network (either railheads or roads). They are often found on the border regions of States and thereby form something of a buffer population. But they are usually exploited by the people of both the adjacent regions.

In the recent past several types of development projects have been undertaken which have disturbed the tranquility of the tribal areas. Rapid industrial growth, exploitation of mineral resources, urbanisation, construction of roads, etc may have taken India forward in leaps and bounds, but these have also increased pollution, destroyed forests and the country's ecological balance. The tribes of India who are least equipped to adjust to this ecological change are paying the heaviest price for progress.

A small percentage of tribals like the Chenchus, Irulas, Kurumbas and Kadars are food gatherers and hunters, living in the forested areas of the Nallamalai, Nilgiris and the Annamalai hill ranges. They are small groups numbering a few thousand each and subsist wholly on collecting wild foods from the forests. However, the larger proportion of the tribes of peninsular India and northeast India have been practising a primitive form of agriculture on gentle hill slopes called shifting cultivation or slash and burn agriculture. This form of cultivation simply needs muscle power and an axe. Some of the tribes, also practise settled cultivation with the plough if flat land is available and are in transition between the two types of agriculture.

The nature of their subsistence economy, which is dependent on the unpredictable monsoon, forces these tribes to turn to the forest for food gathering. In the lean pre-harvest periods, especially during the monsoons, the forests provide an abundance of wild plant foods which supplement their diet. This variety of wild foods adds both quality and quantity to the monotonous cereal diet, making it nutritionally more balanced. The surplus wild foods are also dried, stored and eaten when required.

Forest food

A variety of tubers (mostly *Dioscorea sp*), tender bamboo shoots, mushrooms and green leafy vegetables sprout with the first rains and are collected and eaten immediately or dried and stored for future use. On an average, adult tribals daily eat at least 600 gm of tubers each and this provides them with a substantial amount of energy (3000 Kcal) and protein (30 gm). An equivalent amount of these wild tubers provide more than twice the amount of protein than potatoes. Bamboo shoots and mushrooms are also a good source of protein. The amount of fresh bamboo shoots eaten daily by adult tribals contributes on an average 35 per cent of vitamin B_6 and 17 per cent of vitamin B_1 to their diet. This helps ward off vitamin B-complex deficiency common in people dependent on a monotonous rice diet. Excess bamboo shoots are also cut, dried and eaten whenever needed. The variety of green leafy vegetables available during the rainy months supplies iron, a deficiency of which produces anaemia, and vitamin A, the lack of which is a common cause of blindness in children in India.

In the summer, tribal people collect a variety of edible fruits found in the forest. In March, Mahua flowers (*Bassia latifolia*) are collected by the whole family in the early morning hours. These are dried in the sun and eaten after boiling. They provide an important source of energy, calcium, vitamin B_6 and Niacin. An equivalent amount of dried Mahua flowers provides a greater amount of vitamin B_6 and Niacin to the diet than either sorghum or rice. Mahua is also used for distilling liquor and can, therefore, be sold; the cash provides the tribal with some of the minimum material requirements like clothes, pots, salt, etc from the weekly market.

In May, wild mangoes form an important food for the tribals of peninsular India. There are plenty of wild mangoes in the forests. The kernel of the seed, which forms a greater proportion of the fruit, is dried and pounded into a powder which is used for making chapatis. This dried powder provides protein, a substantial amount of carbohydrates and calcium.

Besides food, the forest also supplies the tribals with their requirements of building materials, fuel and fodder. In addition, minor forest produce like gum, honey, Mahua flowers, beedi leaves etc, are collected and sold to earn cash. Hence, denial of tribal rights over forests or destruction of forests upsets their entire lifestyle.

Linked to forests

The tribes of central India are traditionally associated with forests. Each has a distinct geo-morphological territory surrounded by forests which it considers its own. Within each tribe, the clan or village has its distinct forest tract with specific boundaries. Until mid-19th century, tribal populations lived in peace and isolation but with the British extending their rule, these areas came under the administration of the Central Government. Under the protection of the British administration, many non-tribal settlers migrated and succeeded in acquiring large tracts of tribal lands. The interference with tribal life came to such a head in the 19th century that even these inherently peaceful tribals revolted against the authorities. This resulted in the Santhal Rebellion in Bihar (1855-56), the Bhil Rebellion in Khandesh and the Rampa Rebellion by Konda Reddis in East Godavari district (1879).

Unlike central India the northeastern hill areas were protected by a policy of non-interference followed by the British. This enabled the hill tribes there to retain their traditional ownership of land.

Since the beginning of the 20th century, the tribals have faced a new threat because of the need for commercial exploitation of forests. In order to tap the forest wealth, large areas were "reserved" by the British Government and put under the control of state machinery. This has now become a constant source of friction between tribals demanding their traditional rights over forests and the Government claiming the right to manage the forest wealth.

Since the last 30 years the Government has taken active measures to restrict the tribals' traditional form of agriculture — shifting cultivation — in hilly terrains in Central India. Different policies of either allowing it in some areas or restricting and completely banning it in other areas are being followed. Sometimes these policies vary within the same State. The Government justifies banning shifting cultivation by saying that it destroys forests.

Tribal medicines

While family planning experts rack their brains to persuade women in Indian villages about the value of contraceptives, they overlook the traditional knowledge that people already have on this subject. For instance, tribals living in the Karjat tribal block in Maharashtra have used a native herb which when taken twice stops conception for more than a year.

Similarly the Kurichean tribals of North Kerala use the seeds of a wild banana to cure urinary disorders and Murai girls of Bastar in Madhya Pradesh, who freely indulge in premarital sex, eat a combination of herbs to prevent pregnancy. According to Dr B.S. Rao of the Botanical Survey of India, the plant drugs used by the northeastern tribals can cure a wide variety of ailments like fevers, bronchitis, blood and skin diseases, eye diseases, lung and spleen ulcers, diabetes, blood pressure and others.

According to botanists, every region, be it desert, mountain, plain or forest , has some flora known to possess medicinal value. A survey of the Karjat tribal block, conducted by the Academy of Development Science has revealed that in a small area of 277 sq km there were 210 medicinal plants.

Yet all this vital information is disappearing without any record, with the gradual erosion of tribal cultures while the scientific community continues to treat the subject with indifference and disdain.

Ethnobotanists — botanists who study the use of plants by human beings — look upon tribal cultures as invaluable storehouses of informatioin which have evolved after centuries of incessant interaction between the tribals and the flora and fauna of their immediate surroundings. The dietary patterns and the medical and birth-control practices of each of the Indian tribes can yield rare information about natural drugs, contraceptives, sources of new foods and causes of modern urban ailments like high blood pressure and heart condition.

So far most of this knowledge about the use of medicinal plants has been passed down orally through "vaiyas" or herbal medicine doctors. Many of them guard this knowledge and do not easily divulge it to outsiders. Also, over the years, some of the value of herbal medicine has been undermined as its practice has got mixed up with superstition.

Nonetheless, there is an adequate scientific basis to it, which if recorded, could be tremendously important for India. The Karjat study group concludes that "there are indications that traditional health practice can contribute at least up to 50 per cent towards self-reliance of primary health needs."

Besides their use in traditional medicine, many medicinal plants provide chemical derivatives for modern allopathic medicines. A number of the "wonder drugs" discovered between 1945-60 are actually time-tested drugs that have been used by primitive tribes since ages. One example is the Ayurvedic herb *Rauwolffia* whose deriavatives have been a phenomenal success in treating mental illness.

The tribes of Kameng and Lohit in Arunachal Pradesh crush the bulb of *Fritillaria cirrhosa* to a paste which they apply to relieve muscle pains. Although Indian scientists were slow in following up the medicinal value of this plant, Soviet research on another species of *Fritillaria* has revealed the existence of a chemical similar to cocaine which gives quick relief to muscular pain.

If properly studied, analysed and recorded, these customs of Indian tribal communities have the potential to revolutionise the world of medicine.

Which is the weaker sex? Building materials and excavated earth at most construction projects in India are generally transported by women. Tribals form the bulk of the labour force at these sites. (WHO/P.N. Sharma)

Slash and burn

Shifting cultivation is called "podu" in Andhra Pradesh, "bewar" in Madhya Pradesh and "jhum" in Northeast India. This has been the traditional form of tribal agriculture for centuries. It consists of cutting down a patch of forest, burning it when it dries and sowing the seeds in the ash which is rich in nutrients. After a few years, the patch is left fallow and allowed to regenerate into a forest.

This cyclical period varies according to the type of soil and forest cover, generally increasing in poorer forest areas. As long as the period of the traditional cycle was maintained and the area of operation was not reduced, there was minimal soil erosion. This is because a reduction in the 10-12 years cycle to, say, eight years, will result in a poorer regeneration of the forest in the abandoned podu patches, thus providing less fertility to the soil and increasing soil erosion.

Generally the density of population among podu cultivators is low and each village has a maximum of 16-20 households. In the Abujhmar hill tract (Maharashtra and Madhya Pradesh) the density of population is four persons per sq km. In each family, a man and his wife can cultivate on an average two hectares at a time. The total area cultivated in a lifetime will be about 20 hectares. Each village, thus, owns not more than 400 hectares of land over which the village exercises its traditional ownership.

This form of cultivation provides the tribals with a self-sufficient economy if left undisturbed and each household produces enough for at least two years stock of staple grains, with substantial daily supplementation by food gathered by the women from the forest. Surplus grain is stored for the future eventuality of a poor crop or illness in the family which is quite common.

Experts have often argued that this form of agriculture is detrimental to the preservation of forest and should, therefore, be banned. On the contrary, some of the largest natural forests exist in areas inhabited by slash and burn cultivators, whereas extensive plough cultivations has destroyed forests wherever it has been practised. Large scale commercial explotitation of forests has also led to widespread deforestation.

In Andhra Pradesh, podu was banned in Utnur taluka of Adilabad district in 1950. This inflicted considerable misery on the Kolams and Naikods by dislocating their traditional economy. However in the districts of Khamman, West Godavari, East Godavari, Vishakapatnam and Srikakulam, shifting cultivation on the Eastern Ghats is still the main tribal economy with plough cultivation being practised alongside by those tribal groups who are in a state of transition between the two systems.

Commercialising forests

Since the early 1970s the commercial explotitation of forests has intensified because of the increased requirements of paper mills, rayons and plywood industries. The National Commission on Agriculture urged forest departments to be more productive, as a result of which 18 states established Forest Development Corporations (FDC) to plant commercial species on an extensive scale. These corporations, being independent and corporate bodies, are not subject to State budgets or to the working plans of the forest departments. With the establishment of these corporations, meant primarily to serve industrial interests, the final death blow has been dealt to the preservation of natural forests.

A whole new working scheme has been framed. The new unit of management is the "industrial catchment", an area which may encompass one or more districts, earmarked to meet the requirements of a particular industry. Industrial catchments consist of the most productive forests in the states to ensure quick return on investment. Vast areas of good forests have been clear felled, the timber sold to generate profits for the corporations and the deforested area replaced by commercial species such as teak, eucalyptus and tropical pines. Fruit trees, especially wild mango, have been felled because the wood of these trees is suitable for plywood industries. The wood of the mango trees is sold at Rs 74 per cubic metre to the plywood industries in Andhra Pradesh, and these huge noble trees are fast disappearing from the forests, perhaps causing a permanent loss of wild mango strains in the country.

Thus, with the establishment of these forest corporations, the traditional working plans geared somewhat towards conservation of forests, have been shelved. The activity of these corporations in substituting large areas of natural forests with commercial species and thus disrupting the tribal lifestyle, has sowed the seeds of discontent among many tribal groups.

Industrialisation

Besides the destruction of forests, several other aspects of economic development have directly disturbed the tribal environment. One of the them is the process of industrialisation. Forest regions are often rich in mineral wealth. In many states establishment of industries, hydro-electric projects and mining operations has led to large-scale displacement of tribals.

In the Singhbhum and Ranchi districts of Bihar, for instance, a large number of tribals have been displaced to establish heavy industries. No special programmes or facilities were made to meet the needs of these tribals or plan for their resettlement or rehabilitation. They were paid for their land and in most cases this money was wasted on liquor or other non-productive purposes. Deprived of the forest and their agricultural land, most tribals have ended up taking jobs as household menials or as unskilled workers in the plants. They are welcomed by the industry during the construction phase, but once these industries start functioning, tribals have to move out as they lack technical skills.

In the mines of Bihar, Orissa, Andhra Pradesh and Madhya Pradesh, most of the unskilled workers are local tribal wage earners who have lost their forests and agricultural land to the extension of the mines. The living and working conditions of these tribals is pathetic.

Few sites are more painful reminders of the rapidly deteriorating environment faced by tribals than the Bailadilla iron ore mines in central Bastar. An entire tributary of the Indravati, called the Shankni river, has turned red with the ore wash.

According to P.L. Jadia, the general manager of one of the Bailadilla mines, some 15 villages have been affected by such pollution. The downstream villagers have been denied drinking water as a result. The former Collector of Bastar, H. Mishra, alleged that the very number of villages affected is

The cave-dwelling Cholanaickans of Kerala are among the most primitive tribes in India. About a hundred strong, their existence is threatened by venereal disease and liquor — gifts of civilization. (India Today/Raghu Rai)

in dispute: some estimates are as high as 50.

The National Mineral Development Corporation (NMDC), which runs the mines, has tried to put up a tailing dam near the base of the Kirindul excavations so that the traces of metal can settle and clear water run off. "But the villagers have threatened our surveyors with bows and arrows and for the last seven years we have been unable to do anything," complains Jadia.

Samples of water have been sent to the Water Pollution Control Board in Bhopal for analysis. Meanwhile, some handpumps and wells have been sunk to provide water in the villages. But the tailing dam, estimated to cost Rs 116 lakhs, is still unbuilt.

A Planning Commission study team which did a statewise survey of the impact of developmental programmes on tribals suggested that the adverse impact of industrialisation on tribals ought to be minimised by providing displaced tribes with land for land and house for house. The team has also suggested that before establishing a project in a tribal area, the needs for skilled labour for the project should be assessed and training programmes started to train local tribals. Otherwise there is an influx of non-tribals and the local people become a minority in their own land.

Refugee settlements

Another cause of encroachment on forest areas which affects the tribals, is the allocation of forest lands to settlers. Large areas in northeast India, particularly in Assam, have been given over for settling East Pakistani immigrants. Another such area is Dandakaranya in Orissa and Madhya Pradesh where East Pakistani refugees were settled, in the process displacing the local Koya tribals.

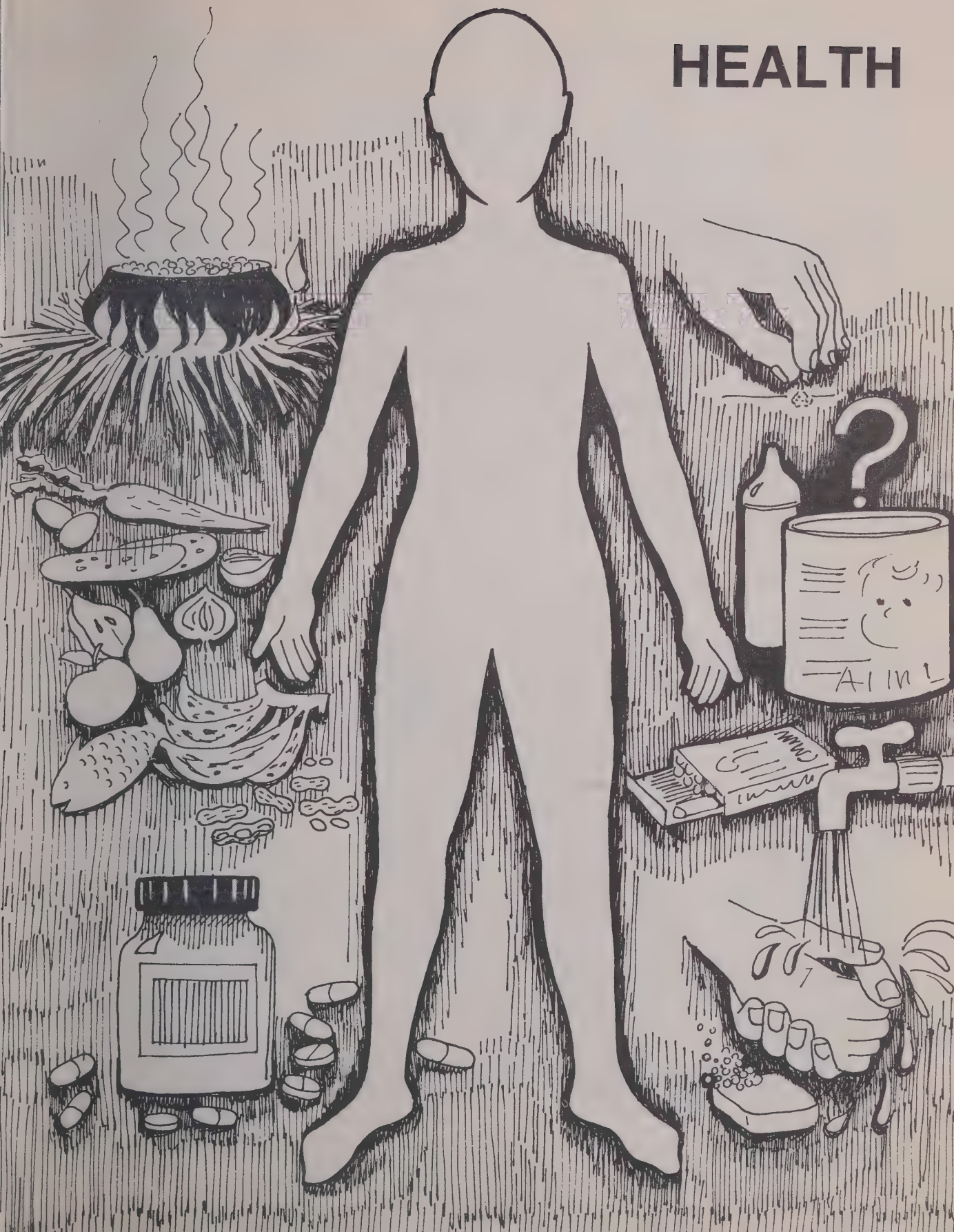
The Planning Commission Study Team on tribals also observed that some of these State Governments were giving more generous monetary help to the refugees than to the tribals. For instance, the refugees settled in Dandakaranya were given Rs 3700 per family while tribal families were given only Rs 1700. Further, the tribals were not given any medical facilities nor cooperative arrangements for the supply of improved seeds.

In all tribal areas, from the northeast to the south, where developmental projects or industrialisation have brought with them scores of non-tribals as well as bureaucrats with no appreciation or sensitivity towards the tribal ethos, the worst sufferers have been the tribal women. They have been violated and exploited by non-tribals in all garbs. The scar this has left on the tribal groups goes as deep as the one caused by the exploitation of their precious and sacred forests. The extent of their disgust with "mainstream" India can be judged by the various political movements that have emerged amongst tribal groups in the last 30 years.

There is an untold wealth in tribal cultures that can benefit so-called "modern" society. Their philosophy and approach towards nature and all its creatures, in particular, has a wisdom which is desperately needed at a time when consciousness about the damage done to the environment by modernisation is beginning to seep in.

Instead of tapping this source of environmental commonsense, mainstream India is alienating the tribals of India, forcing them into further economic hardships.

HEALTH



India faces a disastrous 'double burden' of disease. Most old diseases continue to be rampant while new ones are making rapid strides. The Indian death rate is no longer going down.

Every third person who dies in India is a child below the age of five; a victim of a vicious combination of poverty, malnutrition, insanitary environment and unclean drinking water.

Diarrhoeas attack children in particular: three die every minute, about 1.5 million every year. Diarrhoeas, thus, constitute a permanent epidemic in the country.

The extension of irrigation is creating excellent breeding grounds for disease carriers, including the mosquito that spreads the fatal disease of Japanese Encephalitis, almost unknown in India 30 years ago. Every third person in India now lives in danger of falling prey to filariasis.

With water pipes empty most of the time and sewage seeping into them, hepatitis is increasing by leaps and bounds. The government does not even want to make it a notifiable disease.

Increasing use of cigarettes and bidis and greater use of chemicals because of industrialisation already results in half a million deaths from cancer every year. By the end of the century, India could be an unenviable country with so-called diseases of poverty and affluence co-existing with each other.

8

HEALTH

Health in India today stands at a crossroad. Not only have the health services failed to reach the majority of the population, the country's disease spectrum is itself getting transformed. Many new diseases are coming in because of changing ecological conditions. As a result, the challenge to the country's health planners is increasing rather than decreasing.

That the health of a nation is not dependent on the number of doctors and hospitals has become increasingly self-evident over the last decade. For instance, the most important environmental factor linked with health, or rather ill-health is water. Eighty per cent of the world's diseases are linked to water. As an indicator of health, the number of water taps per head of population is more important than the number of hospitals or doctors, says WHO's director-general, Halfdan Mahler. Yet health planning has revolved around building hospitals and medical facilities with little attention being paid to providing clean drinking water or improving environmental sanitation.

Besides the emphasis in health planning being on the curative rather than preventive aspects, the facilities that exist are biased in favour of the city-dweller. According to 1977-78 figures, there were only 5400 primary health centres (providing the minimum of health facilities) covering a rural population of 439 million living in the 576,000 villages of the country. In contrast there were 5100 hospitals, situated mainly in urban areas, with a number of them providing the most up-to-date facilities, for the 109 million urban dwellers. Several reviews of health services in the country have pointed out the urgent need for primary health care programmes.

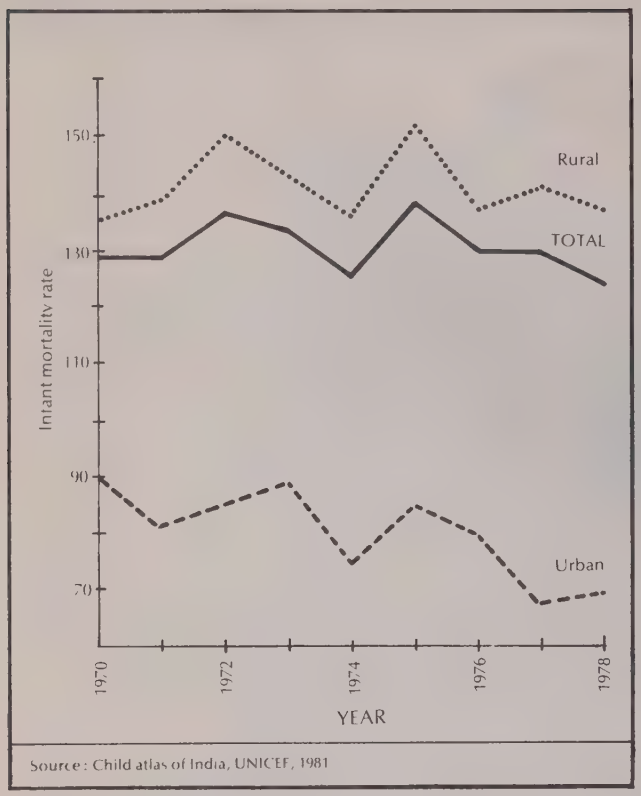
An integrated approach to health care would also mean preventive programmes that attack the environmental factors responsible for the spread of disease. For instance, checking malaria would involve destroying breeding grounds and checking dysentery would mean the provision of clean water and sanitary facilities.

A lack of such an integrated approach presages a menacing future for the health of the country.

● With the sole exception of smallpox, almost all important diseases like tuberculosis, leprosy and diarrhoeas continue to be rampant, and there are no immediate

A rural ambulance. For most people in India the nearest health post is still miles away. Life ebbs away in many cases even before the journey is complete. (The Hindu)

Figure 1. Infant mortality in India, 1970-78



Source: Child atlas of India, UNICEF, 1981

Table 1. Estimated crude death rates, 1978

(Deaths per 1,000 population)

Below 6.0	
Chandigarh 4.3	
6.0-9.0	
Kerala 7.0	Manipur 7.0
Andaman & Nicobar 8.3	Delhi 8.1
9.1-12.0	
Himachal Pradesh 11.8	Jammu & Kashmir 11.7
Karnataka 11.7	Maharashtra 10.3
Meghalaya 10.2	Punjab 11.6
Tripura 11.6	West Bengal 11.7
Goa 9.2	Pondicherry 10.6
12.1-16.0	
Andhra Pradesh 13.2	Assam 13.1
Bihar 12.1	Gujarat 12.7
Haryana 13.4	Madhya Pradesh 15.1
Orissa 14.1	Rajasthan 15.6
Tamil Nadu 12.8	
Above 16.0	
Uttar Pradesh 20.2	

(Data for certain States/Union Territories are not available)

Source: Child atlas of India, UNICEF, 1981

prospects of these diseases being reduced drastically or eradicated.

- Malaria and kala-azar, thought to have been eradicated, have returned.
- Diseases like hepatitis and filariasis, and many new and killer diseases like dengue and Japanese Encephalitis, are spreading because of the changing rural and urban environment.
- Commercial pressures and so-called modernisation trends are combining to bring in a range of diseases — which can be termed "commerciogenic" diseases — like cancer, exacerbated by the sales pressure of the tobacco industry; infant diarrhoeas leading to death, due to sales pressure of the milk powder industry; and, antibiotic resistant strains of diseases caused by the combined pressure of the medical profession and the drug industry to overprescribe drugs.

To deal with the underlying environmental factors responsible for this changing disease spectrum there will have to be a drastic change in the Government's health policy over the next couple of decades.

HEALTH AND POVERTY

The effect of high levels of mass poverty on health conditions in India is becoming clear from the fact that death rates are no longer declining the way they did in the 1950s and 60s

There has been no fall in infant mortality rates in the last decade, specially in the rural area, and children today constitute a substantial percentage of deaths in the country. Every third person who dies in India is a child below the age of five. Several population experts argue that unless there is a drastic reduction in child death there will be little incentive for parents to have fewer children.

At present, infant mortality in India is around 126 deaths per thousand infants born — in other words, every ninth child born in the country dies before the first year of birth.

While available medical services have done all they can to reduce mortality, especially adult mortality, from infectious diseases most amenable to direct treatment and control, such as malaria, they are unable to break the back of poverty-generated ill-health conditions. Nutritional levels in society and environmental conditions like insanitation and unclean drinking water are major factors in determining infant mortality rates.

Several analyses of mortality rates of urban and rural India, as well as of the different states, have shown that they are closely related to differences in environmental conditions, levels of affluence, access to medical services, education of women and assured food supplies. While overall mortality rates in Indian villages fluctuated between 16 and 19 per thousand and infant mortality rates between 136 and 151 per thousand during the 1970s, in the cities, death rates fluctuated between 9 and 10 and infant mortality rates between 70 and 90

Similarly, there are variations amongst the States of India. While backward Uttar Pradesh had a death rate of 20.2 per thousand in 1978 as against a national death rate of 14, Kerala had a death rate of only 7.0, which is comparable to death rates in many industrialised countries. Again, UP had an infant mortality rate of 178 as compared to the national average of 129 in 1976, while Kerala had an infant mortality rate of only 56. Also, while UP had an estimated birth rate of 40.4 in 1978, as against the estimated national birth rate of 33.2, Kerala's birth rate was only 25.2.

The reasons for the better health of Kerala's population remains a matter of debate amongst scientists and experts. But high levels of literacy — especially amongst women — environmental sanitation, and government-assured food supplies appear to be some general factors for this remarkable demographic situation in Kerala. Curiously even Punjab, with its remarkable rate of economic development and high levels of food production, is unable to match Kerala. Some observers argue that while economic growth in Kerala has benefitted women, Punjabi women have not gained to the same extent. In other words, the social status of women may be a vital factor in affecting the overall health of a population.

A study of the achievements of various voluntary health care groups across the world, including India, shows that if environmental standards and levels of nutrition can be improved, dramatic changes in health levels are possible without increasing existing expenditure on health services. It would only have to be diverted towards community health services and health workers. The problems of mothers and children are the most important in society and health services tend to neglect them the most: they are the most difficult to reach from a primary health centre. Trying to cure diarrhoeas, for instance, from a primary health centre is something like trying to empty the Indian Ocean with a spoon. Infant mortality from neonatal tetanus, respiratory infections like pneumonia, and diarrhoeal diseases cannot be contained, much less reduced, in the absence of appropriate health services and rural development, including santitation.

The Diarrhoea complex

Whereas diarrhoeas by themselves are seldom little more than a nuisance, diarrhoeas combined with malnutrition are a vicious killer. The National Institute of Nutrition estimates that over 85 per cent of children between the ages of one and five suffer from mild, moderate or severe forms of malnutrition. In India, an estimated 1.5 million pre-school children die every year from diarrhoeal diseases other than cholera, which means three children die from diarrhoeal diseases every minute. Diarrhoeas, thus, constitute a permanent epidemic in the country.

Diarrhoeas are usually not a major problem for children while they are being breastfed but once the weaning process starts the diarrhoeas set in. Over one-third of deaths amongst Indian children between the ages of one and four are attributed to diarrhoeas. This situation will inevitably continue until water supply and sanitation services spread further.

One person in every three lacking clean water or adequate excreta disposal facilities in the world is an Indian. At the start of the UN-sponsored International Drinking Water

Guinea worm

A disease that afflicts nearly seven million people in India, but which can be totally eradicated like smallpox, is guinea worm. Nearly 8000 villages of Rajasthan, Madhya Pradesh, Andhra Pradesh, and Karnataka are afflicted with this dreaded disease and their numbers are steadily increasing.

A villager becomes infected with guinea worm after drinking water containing Cyclops, microscopic waterfleas, that have fed on the larvae of the worm. Within the human body, the larvae develop into long worms, which break out about a year later through the skin with an acute burning sensation. Although they are found mostly in the legs, they can appear just about anywhere: breasts, abdomen, fingers, eyelids, lips and even the tongue. The worms can grow as long as 1.7 metres.

Once infected, there is no drug suitable for effective treatment. One ancient and well-known treatment is to wind the worm around a small stick and then slowly pull it out, a little every day. This process, however, is dangerous because if the worm breaks, a severely infected abscess results. Complications like arthritis and oedema are also known.

Prevention of this disease is neither difficult nor expensive. The cycle is maintained by people stepping into their drinking water source — a shallow pool, step well, or pond — thus, releasing the larvae into the water from the affected part (usually the lower leg). Patients also often tend to bathe the affected part in water to relieve irritation.

Either by supplying clean drinking water to all the inhabitants of guinea-worm infested villages or by converting step wells into draw wells so that people can no longer put their feet into the drinking water source, the cycle of the worm can be broken and the disease eradicated. By converting step wells into draw wells, the disease was eradicated in Tashkent and Samarkand in the Soviet Union, nearly 40 years ago. Since the Cyclops is a rather large insect, the public can also be educated to use a double-thickness cotton cloth to filter water before drinking it, a measure that has proved to be effective in West Africa.

Though the Government has set up a task force for guinea worm eradication, steps to provide clean drinking water to affected villages or to convert step wells hve been slow and unplanned. Nearly all the guinea worm affected villages a lack sources of clean drinking water but few of them have been included in the water supply schemes launched during the Sixth Five Year Plan.

There is no disease easier to control than guinea worm. Yet health planners often neglect it because it does not kill. But they forget that it can incapacitate a farmer for as long as three months just at the time of peak agricultural activity. In endemic areas, a large proportion of the population can get affected. A survey in Andhra Pradesh, revealed that many people get repeatedly infected, as much as 50-100 times, and suffer for 20-30 years at a stretch.

Simple home treatments for diarrhoea are now known, but they are not propagated. Instead, children are taken to distant facilities for saline drips. (WHO/D. Henrioud)

Supply and Sanitation Decade (1981-90) — whose target of "clean water and sanitation for all by 1990" has been accepted in UN resolutions by all governments of the world — the Indian Government had indicated to the United Nations that by 1990 it would try to cover all the villages and towns of India with clean drinking water supplies. In addition it would aim to reach about 80 per cent of the urban population and 25 per cent of the rural population with adequate excreta disposal facilities.

Given the existing situation, where only 30 per cent of the rural population is covered by clean water supplies and 47 per cent of the urban population and two per cent of the rural population covered with adequate excreta disposal systems, things are unlikely to improve dramatically within this decade. However, with respect to rural water supplies, the Government hopes to bring clean drinking water before 1990 to all the 100,000-odd problem villages which have no assured water source within a mile or, if they exist, are extremely polluted.

Water and infection

There are certain trends within the water supply and sanitation sector which are disturbing from a public health point of view. First, even though the proportion of the urban population covered by municipal water supplies is increasing. — it now stands at over 80 per cent — the quality of water supplied has been constantly deteriorating. People in many of the largest cities of India who received running water for 8-10 hours daily in 1970, received only two to three hours in 1975. Nothing is more dangerous to public health than intermittent water supply. The chances of sewage water from the leaking sewers entering the nearby water pipes are high when pressure in the empty water pipes is low. An intermittent supply of water leads to a negative pressure within the water pipes, drawing in sewage and faecal material. The contamination of drinking water is seldom at the source.

As much as 90-100 per cent of the urban population in the states of Gujarat, Maharashtra, Manipur, Nagaland, Orissa, Punjab, Rajasthan, Tamil Nadu and West Bengal is receiving intermittent water supplies.

It is no wonder that the incidence of hepatitis (jaundice) has been increasing dramatically in most Indian cities — and from there it is now slowly spreading to rural areas. Its incidence in the last five years may be more than that of the previous 15 years combined.

The second unfortunate trend in the public health system is the growing gap between water supply and sanitation services. Although 2092 urban communities have been provided with piped water supplies, only about 217 out of 3126 towns have sewerage systems. In the rural areas, the gap is even bigger.

The fundamental health reason for supplying clean drinking water is to reduce the incidence of waterborne diseases. But increasingly, scientific evidence shows that supplying clean drinking water is not enough.

The Government's clean drinking water programmes in poor urban and rural communities mainly consist of community water supply schemes because of the massive investments that would be required to pipe water to every home. But while community water taps do supply clean water, there is no guarantee that the collected water will remain clean once it is transported and stored at home, especially in an insanitary environment.

A survey conducted by the Gandhigram Institute in five villages in Madurai in 1971-73 showed that people using street taps had a higher incidence of diarrhoeas and shigellosis (a bacillary dysentery which can hit children badly). The study found that there was a high risk of water contamination during transport and storage. Clean water was often

Dirty utensils, dirty hands and dirty water vessels transmit diarrhoeal diseases. Clean water from the tap is not enough.

collected in dirty containers.

Surveys on diarrhoeal diseases have been carried out in Mauritius, Sudan, Egypt, Sri Lanka, Iran, Bangladesh and Venezuela. All these surveys conclude that provision of piped water supply to a community with only basic sanitation leads to minimal reductions of diarrhoeas, dysentry, etc.

Many skin and eye diseases (scabies, skin sepsis, fungal infections and trachoma), for instance, are not waterborne at all, but they are greatly influenced by water use practices in a community. There are other infections that are spread by fleas, ticks, lice and mites. All these diseases can be classified as water-washed diseases and their incidence is likely to be affected more by the quantity of water than by its quality.

These findings clearly show that drinking water supply programmes must be accompanied with sanitation programmes and health education programmes aimed at improving personal hygiene, if public health benefits possible from community water supply schemes are to be obtained. Unfortunately, in India today, there is little interest in pushing sanitation and health education programmes.

In urban areas, slow progress in sanitation programmes is due to technological perceptions — the undue emphasis on sewerage systems to the total exclusion of cheaper non-sewerage alternatives.

In rural areas, a combination of sociological, behavioural and economic factors that rural development bureaucracies and extremely difficult to overcome slow down moves for sanitation.

Partly because of the lingering influence of Mahatma Gandhi, India's First Five Year Plan in 1952 alloted 83 per cent of the combined budget for rural water supply and sanitation to sanitation programmes. But by the Third Plan, disenchantment with the result had become so great that nearly all of the rural allocation was being spent on water supply. Commenting on this programme, WHO stated in 1974 that heavy investments in rural water supplies, to the almost total exclusion of rural sanitation, would have little beneficial effect on health. In such circumstances, the diarrhoea epidemic will continue.

Wonder cure

Fortunately, scientists have now found an amazing cure to this number one public health problem which can drastically reduce mortality from diarrhoeas if not actually prevent their high incidence. A pinch of salt, a scoop of sugar, mixed with a glass of water and fed by the mother to the child after every stool, can mitigate the worst effect of diarrhoea, that is, dehydration, almost completely. Where sugar is not available, mothers could use "gur". Latest research shows that where even this is not available, salt added to rice gruel would be reasonably effective. As these substances are readily available, a massive education programme to teach mothers how to handle diarrhoeas themselves, obviating the need for doctors, intravenous drips or medicines, would be successful. Unfortunately, the Government remains complacent. This technique has been known for over a decade now. It saved thousands of lives in the cholera epidemic amongst Bangladeshi refugees in 1972 and has also been tried out successfully in a few diarrhoea epidemics more recently. But for almost a decade now, the wonder cure for diarrhoeas awaits a carrier to spread it; probably because, as some cynics put it, rich children never die from diarrhoeas. Amazingly, the Ministry of Health does not even have one full-time staff assigned to the control of diarrhoeal diseases.

A PINCH, A SCOOP, A GLASSFUL

A simple technique for treating diarrhoeas is to replenish lost body fluids with a mixture of a pinch of salt, a scoop of sugar, and a glassful of water several times a day. So many lives could be saved by this technique, but there is no effort to teach it to those who need it the most — the poor.

The bottle disease

A third disturbing trend in this field is the result of so-called modernisation: bottlefeeding. Breast-fed infants seldom suffer from acute diarrhoeas, and even if they do, they recover fast, partly because of immunity to a variety of infectious diseases passed on by the mother's milk to the child. It is usually in children between the ages of one and four, when the weaning process starts, that acute and repeated bouts of diarrhoeas tend to set in.

In recent years, commercial manufacturers of milk powder have been changing all that. With the habit of bottle feeding catching on amongst poor families with little access of fuel or clean water, acute diarrhoeas amongst infants, eventually leading to death, are becoming common. Despite an international outcry against this "commerciogenic" disease, baby milk powder continues to be advertised to the public in India, even on government television. (See box)

Sanitation essential

Moreover, dirty hands transmit enough germs to keep the incidence of diarrhoeas within a community high even if it has a community water tap. Water consumption from community taps usually remains limited to drinking and cooking purposes. The total quantity consumed varies according to the distance from the tap to the house. There is inadequate water to keep washing hands all the time in most poor

The killer still at large

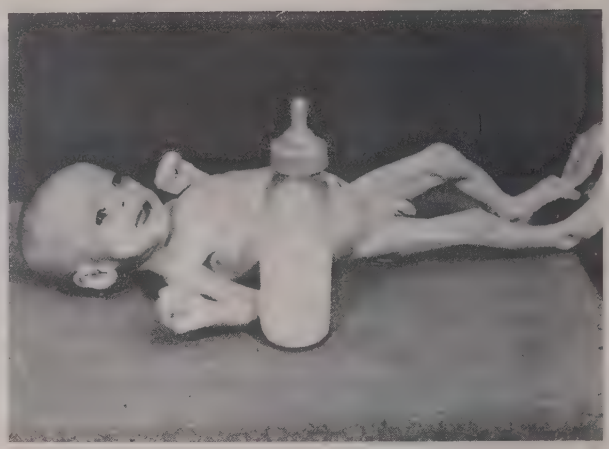
A year ago nations of the world angrily, and almost unanimously, called for a ban on the promotion of baby milk powder. Yet the WHO resolution, then hailed as a major Third World victory over the mighty multinationals, is slowly turning out to be a damp squib. Hardly any government — from Bangladesh and India in Asia to Mexico in Latin America — has cared to translate the resolution into real action back home.

The switch from breastfeesding to bottlefeeding has been described by many scientists as the most dramatic change to have occurred in biological behaviour since human beings emerged. But it has now been proved to be a harmful form of modernisation encouraged by the unethical marketing practices of private companies. These include sending sales representatives to maternity wards dressed as nurses to advise mothers that milk powder is best for their babies.

India presents probably the most dramatic case of a weakening in political will over the last year to control milk powder companies — notwithstanding Prime Minister Indira Gandhi's rousing speech in Geneva at the WHO. A working group of the Ministry of Social Welfare had formulated a code for marketing of milk powder even before the WHO meeting began in May 1981. The code stipulates not just a ban on advertising of milk powder but also of weaning foods. But instead of becoming national legislation by now, the code still remains a confidential document. Even though 24 out of 25 members of the working group signed the final report nearly a year ago, the 25th member still has to sign it. The Government has not yet stopped advertising of milk powder on television either.

The pressure on the Indian Government has come from Amul, India's leading milk powder manufacturer. Its managers insist that a ban on advertising milk powder is unnecessary because only about two per cent of Indian babies are bottle-fed, and these are mainly rich children with access to clean water.

Dr R.K. Anand, a leading breastfeeding compaigner who was a member of the Government's working group, strongly disputes these claims of milk powder manufacturers. He points out that studies have shown that the incidence of bottle feeding in urban areas across India varies from 10 to 28.6 per cent in poor families and 60 per cent in middle class families. In his own hospital — the Nair Charitable Hospital in Bombay — Dr Anand studied 200 consecutive infants admitted to the paediatric ward. Some 55 per cent of these infants were being bottle-fed. Over three-fourths of the parents earned less than Rs 150 per month. Nearly half the mothers bottle-feeding were illiterate. Nine out of 10 bottle-fed babies came from homes without continuous water supply. Out of these 200 babies, 13 eventually die. All of them were bottle-fed.



The problem is, therefore, increasing among the urban poor and is slowly spreading even to rural areas. Augustine Veliath of the Voluntary Health Agencies of India in New Delhi says, "I have travelled across the country from one end to the other and have yet to find a rural chemist who does not stock at least five brands of baby food". Various voluntary organisations recently set up the National Alliance for the Nutrition of Infants (NANI) to campaign for the implementation of the code formulated by the Ministry of Social Welfare.

According to them, the ultimate question really is whether a poor society should allow commercial interests to distort popular feeding habits. Use of milk powder is well recognised to be dangerous for the poor and, therefore, must be prevented from reaching them. As the habits of the rich set the trends for the poor to imitate, it is only legitimate that the rich too must be disallowed from indulging in such socially harmful extravagance.

households. If the nearest tap is 1000 metres away (that is, in real situations, if a poor family is lucky), hardly any one will be committed enough to cleanliness to traverse that distance dozens of times each day.

A survey by the World Bank found that the highest diarrhoeal infection rates were in households which are furthest away from their water sources. Those families with taps inside the house tend to have the lowest infection rates; those with water close to the house have the next lowest; and those with the water source farthest away have the highest. Infants and small children, who generally have a high rate of diarrhoeas, can get infected frequently and repeatedly not by drinking unsafe water but by parents who do not practice good personal hygiene.

THE RETURN OF THE PEST

The biggest weapons in the hands of human beings against disease-spreading insects like mosquitoes and sandflies have been chemicals like DDT. They reduced the incidence of diseases like malaria dramatically. In the process even kala-azar was almost eradicated. But their effectiveness has not lasted long. The latest report of the WHO Expert Committtee on Vector (disease carrying insect) Biology and Control states that the tsetse fly 'which spreads sleeping sickness in Africa' is the only vector species left which has not yet developed resistance to DDT. In fact, in many insects there is now resistance to not just DDT but many pesticides simultaneously.

The WHO report lists a number of important vectors that have become resistant to pesticides in India. *Anopheles culicifacies*, the mosquito which spreads malaria in rural areas, has been found to be resistant to malathion, DDT and HCH and, in some instances, also to fenitrothion in Gujarat and Maharashtra. This multiple resistance has come about partly because of the heavy use of pesticides in cotton-growing fields. Whereas the use of pesticides in public health operations is limited and controlled, it is usually heavy and uncontrolled in agriculture which leads to a rapid development of pesticide resistance even amongst disease spreading insects. The pesticides get washed away from the plants and reach the pools and ponds where mosquitoes breed. The resistance to these pesticides begins at the larval stage itself.

Similarly *Anopheles stephensi*, the mosquito which spreads malaria in towns, has been found to be resistant to malathion in many urban areas. Resistance in the mosquito *Culex quinquefasciatus*, which spreads filariasis, to organophosphate pesticides like malathion has also been reported.

Though there are no published records of resistance to pesticides amongst *Culex tritaeniorhynchus* and *Culex gelidus* in India, they have now been found to be resistant to DDT in neighbouring Bangladesh. These two mosquitoes spread the dreaded disease of Japanese Encephalitis, which kills nearly every second person who is unfortunate to get the disease.

Another disturbing report is the development of resistance to DDT in *Phlebotomus papatasi*, a sandfly that spreads kala-azar. Sandfly populations were suppressed incidentally during the major DDT spraying campaign to combat malaria in the 1950s and early '60s. DDT is being sprayed once again but this time it is aimed specifically at the sandfly.

Pesticide resistance has also spread to other carriers of diseases like body louses, houseflies, ticks, cockroaches

The anti-malaria spraying campaign of the 1960s reached out to almost every household in the country. But the people were not involved in controlling their environment, and malaria has made a dramatic comeback. (WHO/P.N. Sharma)

The mighty mosquito; it has defied the world's chemical industry. An Anopheles Stephensi, the urban malaria mosquito, puncturing a victim's skin. (WHO)

and rats. In laboratories, several major vectors have tended to develop resistance even to various biological insecticides, hailed as the environmentally-safe alternatives to chemical pesticides.

The seriousness of this growth in resistance amongst vectors cannot be over-emphasised. WHO has pointed out that long-lasting and relatively low-cost organochlorines like DDT have been replaced in some areas by organophosphate and carbamate compounds. These are more expensive to manufacture and require more frequent application. (Switching from DDT to malathion can mean five-fold increase in costs.) The compounded effect of costlier pesticides and additional operational expenses, such as transport and labour, has meant that in many developing countries vector control programmes are exceeding expenditure levels acceptable to governments.

"Development" diseases

Equally worrying is the way economic development activities are contributing to the spread of disease. Irrigation systems, for instance, are a major cause of the increase in the incidence of Japanese Encephalitis, a new disease to India. Similarly, the construction of dams in Southern India in areas where well water already has high quantities of flourides, has changed dramatically the character of the disease called fluorosis. It now affects even the young and makes them severely knock-kneed.

In many towns, water supply schemes have been built without provision for proper drainage. The consequent stinking collections of waste water become excellent breeding grounds for mosquitoes. Open drains are quite a common sight in many villages and towns.

Unplanned urbanisation, construction of water projects, migration of people, all help to change the ecology and epidemiology of diseases. As Dr V. Ramalingaswami, director-general of the Indian Council of Medical Research, points out in no uncertain terms: "The health implications of development activities should be given serious consideration before the activities are commenced". He says that activities which have an impact on the environment and ecology need special attention. For instance, water supply to rural areas for agriculture and for human use needs to be accompanied by a water management system so that conditions favourable for the breeding of vectors of human and animal disease are not created.

Malaria and kala-azar

In the 1950s and 1960s when DDT was thought to be all-powerful, the Government hoped to eradicate malaria within 8-10 years. By pumping in enormous funds for malaria control — more than 50 per cent of the health budget — it was argued that malaria could be controlled.

Crippling cost of big dams

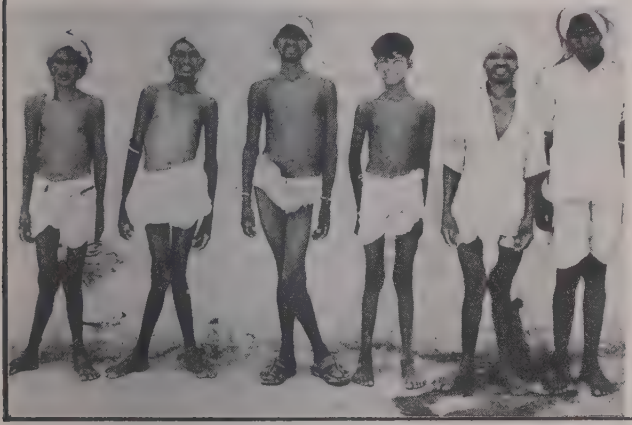
For all those who believe that nature takes its revenge when disturbed by gigantic artefacts, the curious happenings around the Nagarjunasagar Dam in Andhra Pradesh will reaffirm their belief. The sub-soil environmental changes caused by the construction of the dam have triggered off causative factors resulting ultimately in a crippling syndrome of knock-knees (genu valgum) among the poverty-stricken villagers living in the command area of the dam.

Scientists of the National Institute of Nutrition (NIN) at Hyderabad believe that curious but complex and inter-related factors are operating there. Water seepage from the dam's reservoir and canals has increased the level of the sub-soil water. As a result, the alkalinity level of the soil has increased. This in turn has changed the fluoride, calcium and trace metals (copper, molybdenum, zinc and magnesium) composition of the soil, thus creating suitable conditions for increased uptake of molybdenum by sorghum plants.

For people living on sorghum as staple, this has meant a high dietary intake of molybdenum and as a consequence, high excretion of copper and thereby copper deficiency. Associated with a high fluoride intake — skeletal fluorosis has been known to be endemic in these parts for almost four decades now this has meant an acute incidence of genu valgum

Genu valgum can be identified in the people, there, both in standing position and when they walk. In extreme cases, the legs are so distorted that the knee joints cross over. In some others, in the standing position the two feet are separated by over a yard while the knees touch each other. In other cases, an s-shaped deformity of the legs has resulted in a total incapacity to move.

Apart from the severe physical handicap it has imposed, genu valgum has also contributed to serious emotional disturbances and social stress. There are several instances of broken families as a result of married women developing the disease. Affected victims are targets of ridicule, insult and social deprivation. Economic hardship has also visited the affected young men who have been forced to accept lowly paid unskilled occupations having lost their technical occupation. Not merely individuals but the entire community has suffered in the villages studied by the NIN scientists.



A. AGARWAL

Over 75 per cent cases of genu valgum belong to the age group 10-20 years, and detailed history indicated that the deformity sets in at the age of between six and seven years. Only a few cases have been seen in persons over 30 years.

This age trend characterises genu valgum. While skeletal fluorosis is a crippling disease involving the entire bony skeleton, especially the spinal column, it is typically found in the adult male beyond the age of 20 years. Though children do develop signs attributable to high levels of fluoride intake, manifestations are limited to their teeth in the form of mottled enamel. The skeleton is rarely involved in children as fluorosis is a disease that develops very slowly, only after a subject has been exposed to large intakes of fluoride for prolonged periods of time. Thus, the old disease of fluorosis has acquired a new dimension in genu valgum because of the environmental changes caused by the Nagarjunasagar dam.

A detailed examination of the diets of those affected by genu valgum shows that the problem is less frequent among people whose staple is rice in comparison with those who eat mainly sorghum. Since the lowest socio-economic strata take sorghum as their staple, rice being costly, the incidence of genu valgum is higher among the poorest groups of the village populations.

Further studies conducted by the NIN have shown that the problem of severe knock-knees has also emerged in fluorotic areas in Karnataka and Tamil Nadu where new irrigation dams have been built. Genu valgum cases have been found in villages in Coimbatore district situated within a radius of 30 km from the Parambikulam-Aliyar Dam. Similarly, genu valgum cases have been reported from villages near the Hospet Dam in Karnataka.

Although there have been allegations that UN agencies like WHO and FAO were pushed to encourage malaria control programmes by salesmen of pesticide companies, malaria incidence and deaths did come down dramatically in India from some 100 million cases in 1952 to about 100,000 in 1965. And indeed the malaria eradication programme was probably the only disease control programme that actually reached every doorstep in the country.

Moreover, the control of malaria in the Terai region, for instance, played an important part in opening up many areas for agriculture. The euphoria went so far that scientists even stopped research work on malaria and the name of the Malaria Institute of India was changed to the National Institute of Communicable Diseases.

The dramatic resurgence of malaria in the 1970s shattered these dreams. By 1976, malaria cases in India had once again surged up to 6.4 million. Though this rising tendency in malaria cases has now been arrested, the total number of cases still remains over two million each year.

Admitting the defeat of the malaria control strategy at the

Table 2. Recorded malaria cases in selected cities

CITY	1978	1979	1980
Ahmedabad	26,705	30,506	29,711
Amritsar	8,548	8,049	880*
Bangalore	952	820	NA
Baroda	29,866	2,661	4,987*
Bhopal	265*	2,339	3,285
Bombay	2,635	1,605	NA
Calcutta	1,244	2,342	3,227*
Chandigarh	33,635	32,283	47,105
Delhi	332,682	75,625	53,536
Hyderabad	2,559	1,288	1,214
Jodhpur	7,220	3,522	688
Karnal	9,074	6,624	6,175
Kota	1,825	3,614	4,040
Ludhiana	8,276	2,921	NA
Madras	29,453	33,463	36,193

*Indicates partial information NA : Not available

Source: Health statistics of India 1981, Ministry of Health and Family Welfare, Government of India

hands of the lowly mosquito, WHO's director-general said in no uncertain terms: "I am being brutally frank. This time we are not going to fool ourselves. In Africa, for instance, the most we may be able to do is to ensure that everyone who has an attack of malaria can go and pick up some tablets to cure it."

In India too, the increase in malaria incidence has been controlled to a great extent through a massive dumping operation of the anti-malaria drug, chloroquine. It is available in every village either through community health workers or special malaria pill depots. Anybody with a fever can take these pills to cure themselves, a practice called "presumptive treatment". If the fever persists, then it indicates that the person is suffering from some other disease. Pesticide spraying programmes, which were almost discontinued by the late 1960s, have also been taken up in a big way.

Malignant Malaria

Another alarming problem, besides the spread of insecticide resistance in mosquitoes, is the increasing resistance to chloroquine of the most dangerous form of malaria, *Plasmodium falciparum*, also known as malignant malaria. *Plasmodium falciparum* kills 40 per cent of its victims if they go untreated. Resistance of the malaria parasite to chloroquine is a phenomenon already widespread in Asia and Latin America. In Asia, chloroquine resistance was first noted in the early 1960s in Thailand. But since then it has spread westwards, being first noted in northeastern India in 1973. Now, however, chloroquine resistance is found widely in Nagaland, Assam, Meghalaya, Arunachal Pradesh and Mizoram and has spread slowly to Bihar, West Bengal, Orissa, Andhra Pradesh, Madhya Pradesh, Maharashtra, Mirzapur district of Uttar Pradesh and areas bordering the north of Delhi.

Japanese Encephalitis

Many experts believe that the growing incidence of Japanese Encephalitis (JE) across the north and the western coast of India is essentially because of the spread of irrigation. The disease, often popularly called "brain fever", usually kills one out of every two persons who are unfortunate to get it. It is a seasonal disease caused by a virus spread by mosquitoes.

JE is a new disease for India, especially the epidemic proportions it has assumed in recent years. JE slowly spread from Japan across southeast Asia. A few sporadic cases were first noted in south India in 1955. But in 1973 there was a large-scale outbreak of the disease in various districts of West Bengal. In 1978, still larger outbreaks occurred in Karnataka, Tamil Nadu, Bihar, West Bengal, Assam and Uttar Pradesh. In 1981 cases of JE were reported from Karnataka, Andhra Pradesh, Tamil Nadu, and Pondicherry. JE incidence has been steadily growing: 1434 deaths in 1980 as compared to 962 in 1979.

The factors relating to this southwestward spread across Asia still require to be elucidated, but ecological changes are certainly playing a part. Analysing the reasons for the 1978 JE epidemic in India, a scientist at the National Institute of Virology at Pune has pointed out that in recent years the area under rice cultivation has grown geometrically: multiple crops are harvested and more land is flooded by irrigation. Since mosquito vectors of the JE virus breed in rice fields, an expansion in their habitat has led to an increase in their population and the incidence of JE. A number of Culicine and Anopheline mosquitoes transmit the virus but it is *Culex tritaeniorhynchus* that has been identified as the chief carrier of JE in India.

In normal circumstances, the mosquito transmits the virus mainly to pigs and sometimes to large water birds like pond herons, egrets and ducks. Humans only accidentally enter the transmission cycle of the JE virus.

Although the incidence of JE in India is low because of a limited pig population, its high case fatality makes it a serious public health problem. Between 20-40 per cent of the patients die and sometimes the death rate can be over 50 per cent. The disease is characterised by fever, coma and convulsions and it injures the central nervous system.

JE is not just an environmental disease but also a socio-economic disease in India. The virus affects mainly those who come from the lower socio-economic strata of society. In West Bengal, the people most frequently affected with the disease were members of the scheduled castes, communities that rear pigs and live in proximity with their animals.

A variety of efforts are needed to minimize the number of JE cases, including insecticide spraying, draining of stagnant water and health education. In Japan, periodic draining of rice fields, especially during the mosquito breeding season, which kills the larvae breeding in the water, has successfully reduced the incidence of the disease. JE has steadily declined in Japan, China and South Korea while epidemics have increased in India. Whether measures like draining of rice fields can be successfully implemented in the vast rural areas of India without effective community involvement remains doubtful.

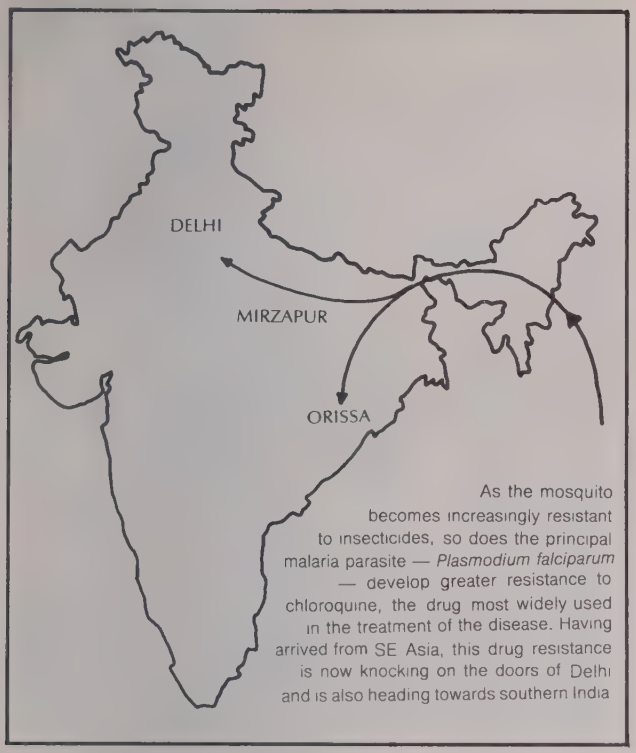
As the JE vaccine has to be kept cool during storge and transport, its widespread use is also going to be difficult.

Concerned by this dramatic spread of drug-resistant *Plasmodium falciparum*, the Indian Council of Medical Research has set up a series of surveillance centres in the northeast to keep a watch on the disease. The spread of drug-resistant malaria, in fact, is the reason why deaths from malaria continued to rise during the late 1970s, even though the incidence of malaria cases has fallen.

Few cheap alternatives

The absence of a cheap and safe alternative to chloroquine poses a big problem. Except for the US Army, which became interested in malaria because of the US involvement in the

Figure 2. The spread of chloroquine-resistant malaria


DELHI
MIRZAPUR
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As the mosquito becomes increasingly resistant to insecticides, so does the principal malaria parasite — *Plasmodium falciparum* — develop greater resistance to chloroquine, the drug most widely used in the treatment of the disease. Having arrived from SE Asia, this drug resistance is now knocking on the doors of Delhi and is also heading towards southern India

Vietnam war (where malaria caused more US casualties than the Vietcong), virtually no one else has initiated the screening of drugs for their anti-malaria properties. Since 1964, the Walter Reed Army Research Institute in the US has screened more than 250,000 compounds. Of these, only seven drugs have been found to be effective in humans. These drugs include mefloquine, claimed to be the most potent drug found against malaria uptil now. But mefloquine is expensive and the cost of mass distribution could be prohibitively high.

WHO has launched a major research programme on mefloquine, including efforts to reduce its cost of production. But as this is being done in collaboration with multinational companies, whether the drug will be available eventually at a low price is doubtful. Moreover, experiments on rodents conducted at the Liverpool University's School of Tropical Medicine have shown clearly that with time mefloquine too can lose its effectiveness against the malaria parasite. Professor Peter Wallace of the school points out: "The more sophisticated and purer the chemicals we develop, and more specific the activities for which we design them, so the easier it becomes for the targets at which we are aiming to evade these very potent substances."

Fortunately, in India the most prevalent form of malaria is not *Plasmodium falciparum* but *Plasmodium vivax*, which has not yet shown any signs of resistance to chloroquine. This is the basis of the massive malaria treatment programme going on in the country at the moment. But inevitably resistance must come into it as well.

Yet another problem before malaria control today is the loss of interest in the pesticides industry for developing effective, cheaper and safer insecticides for public health use. The big market for pesticides has never been in public health, it has always been in agriculture and within agriculture in cash crops like cotton. With growing resistance and cross-resistance amongst vectors, the effective life of a new pesticide is often only a few years. Profit from a new product is thus limited and hence the industry is not interested. The number of insecticides offered to WHO for field-testing for use in public health operations has virtually dropped to zero.

What do malaria control experts do in these circumstances? With the resurgence of malaria, it is now universally accepted that a switch will have to be made from exclusive reliance on chemicals-based malaria control programmes to multi-pronged malaria control programmes, consisting of complicated mixtures of chemicals, environmental and biological control techniques.

Knowledge about biological vector control is limited and its use even more so. In China, a large variety of biological control measures are already used against mosquitoes but in India they are largely in the research stage. Moreover, growing evidence indicates that biological techniques can only work as ancillaries to chemicals, not as replacements.

An effective malaria vaccine, too, is still not developed and no expert really believes that it will be powerful enough to make mosquito control redundant. It may in fact turn out to be a rather weak vaccine. Most vaccines produced uptil now are against viruses and bacteria.

Before DDT came into existence, countries controlled malaria by destroying mosquito breeding habitats. It is to such habitat management that they will probably have to turn again. These measures usually have multiple effects, bringing about simultaneously a reduction in several other diseases. But modern anti-malaria programmes have neglected source reduction work because it is more complex than simple DDT spraying, community-based organisations are necessary and hence results are slow, and it costs more.

Such efforts, however, may be unavoidable. Habitat management is vital in all rice-growing areas, for instance, as rice culture creates favourable conditions for breeding of mosquitoes. Intermittent flooding of rice fields has been made compulsory by law in Portugal as a means of malaria control. In Mexico, where rice is planted in trenches, *Anopheles pseudopunctipennis* can be almost totally eliminated by induced water flow which sweeps away the larvae resting on the water surface. Raising of edible fish such as carp in paddy fields is quite common in China. But such strategies have to be identified specifically for each species; this involves research in vector biology, apart from the enormous efforts required to reach individual farmers and involve them in mosquito-control programmes.

An integrated approach

Professor V. Ramalingaswami's call for an integrated approach to development projects is underlined by several reports which indicate that new developments may be making malaria conditions worse. The Malaria Research Centre's intensive study of the Terai region shows how changing ecology and human migrations can dramatically change its disease pattern. Because of malaria control efforts in the 1960s, the Terai region was not considered endemic for malaria for a long time. The region is agriculturally important to the country and, therefore, has high priority in malaria control efforts. Now the incidence of malaria is high

and the vector, *Anopheles culicifacies*, is resistant to both DDT and BHC. Irrigation water constitutes the main breeding site. The population of Culex mosquitoes, which spread filariasis, is also very high. Mosquito surveys show that their numbers almost always exceeded that of malaria — spreading Anophelines.

Labour for agriculture in the Terai region has come from eastern Uttar Pradesh which is endemic for filariasis. The reservoir of infection in the immigrant labour has made the Terai region also endemic for filariasis now.

The *Culex tritaeniorhynchus* and *Culex vishnui* group of mosquitoes also breed abundantly and extensively in rice fields and other irrigation waters. High densities of these mosquitoes can be found resting and feeding inside structures throughout the Terai region. The region has, therefore, become vulnerable also to various viral diseases that these mosquitoes can spread, including the killer disease Japanese Encephalitis.

Similarly, a study from Tamil Nadu shows how the Sathanur Reservoir has become a major cause for malaria increase in that State. Villages along the course of the south Ponnaiyar River, which passes through three districts, Salem, Dharmapuri and North Arcot, appear to contain the main foci for malaria in the State. An estimated 57.5 per cent of the rural malaria cases in Tamil Nadu were reported from this region in 1976. The Sathanur Reservoir and its vicinity alone accounted for nearly 51 per cent of the reported cases of rural malaria in this state. The incidence of malaria is not found in a continuous stretch, but in patches along the banks of the Ponnaiyar River, especially downstream from the reservoir. The heaviest concentrations of malaria have been found in villages situated within five km of the river. Most of these riverside villages were free from malaria for nearly 20 years.

All the reasons for the reappearance of malaria are not known. Occurrence in patches is apparently due to changing ecological conditions in these stretches because of the introduction of a canal irrigation system completed in 1958. Prior to the canal, water for irrigation had been funnelled through channels, and storage was limited to small tanks. There was little water flow in the river except during the monsoon months.

The reservoir was constructed to regulate the flow of water in the river and to produce larger supplies for the earlier channels. But the canal system has meant a rising water table and water-logging. When rain falls on waterlogged soil, it creates innumerable pools and mosquito breeding for lengthy periods. Breaches in canals, distributaries and water courses are also responsible for numerous breeding places. Small water channels, under the control of local cultivators, are usually ill-maintained and often leak. Frequently mosquitoes breed in the channels and still more in the water leaking from them into any depression in the vicinity. Often the breaching of these channels is done deliberately to provide a place for washing clothes, or watering the cattle, sheep or goats.

Irrigated areas have also attracted several thousands of immigrant labourers who have brought new malaria cases into the region. Conditions of hard work, physical strain, overcrowded and poor housing have further increased the risk of malaria in the region.

However, these reports are not new. Even in the 1940s, reports were published by the then Malaria Institute of India on how perennial irrigation projects in Punjab, Uttar Pradesh and Sind had provided additional breeding grounds for mosquitoes. A recent report from Bastar district links the Sileru hydro-electric and Thandara Project in the Araku Valley with increased mosquito breeding potential.

Several malaria experts now argue that mosquito-borne diseases could not be controlled because while the disease pathogens and the carrier mosquitos were tackled, little attention was given to people. Only if habits of people and their projects are suitably modified can mosquito-borne diseases be controlled. But the applicability of this thesis goes well beyond mosquito-borne diseases. It holds equally well for kala-azar, which is contracted, largely by living close to a cattle-shed, the habitat of the sandfly.

Kala-azar was once believed to have vanished but it has emerged again in Bihar and West Bengal and a few other parts of the country. In the last seven years, the disease has attacked more than 50,000 people and taken a toll of nearly 4000 lives. Infants and children are more susceptible to the disease than adults.

Thus, if headway is to be made in the control of some of the major communicable diseases, including malaria, social anthropologists, health educators, communications experts and engineers will have to become partners with medical practitioners. In Europe and the United States, radical changes in social habits and living conditions followed economic development. These changes played a great part in eradicating insect-transmitted diseases long before the new insecticides and post-war drugs became readily available. Leading authorities on malaria are now convinced that malaria eradication will be linked up with the general socio-economic development of the developing countries.

No country need wait, however, until that happens. The experiences of China and North Vietnam show that with mass education and people's participation in mosquito habitat control measures, and government projects taking environment into consideration, substantial success can be achieved in controlling mosquito borne diseases. Vietnamese experts describe malaria as a "social disease" and stress that "no medical organisation, however large and complete, can lead the fight against malaria to a successful conclusion, if the masses do not adopt its programme."

Filariasis

This is yet another mosquito-borne disease that has spread in the country over the last three decades because of a mismanaged environment. Every third person in India today faces the risk of filariasis — a disease in which once the overt symptoms set in (elephantiasis), there is no satisfactory remedy.

In 1963, the population at risk from filariasis was only 25 million. By 1968, it was 136 million, and in 1976 it was 236 million. This rise is not merely due to population increase; many areas which were once free of filariasis now report cases. The number of persons in India today with filariasis is about 15 million.

The infection is concentrated, though not exclusively, in coastal areas where humidity and a high temperature are optimal for the breeding of mosquitoes. Unsanitary conditions associated with inadequate drainage facilities support the breeding of vectors and the spread of disease. Filariasis

Fifteen million Indians suffer from filariasis. In its final stages, the disease takes on the well-known form of elephantiasis. (WHO/P.N. Sharma)

is also on the increase in villages. Apart from migration of populations, one important reason for this is the increase of water supply without adequate drainage facilities. This problem acquires serious dimensions now with the Government planning to extend drinking water supplies to all problem villages as a part of the International Drinking Water Supply and Sanitation Decade.

The Pondicherry study

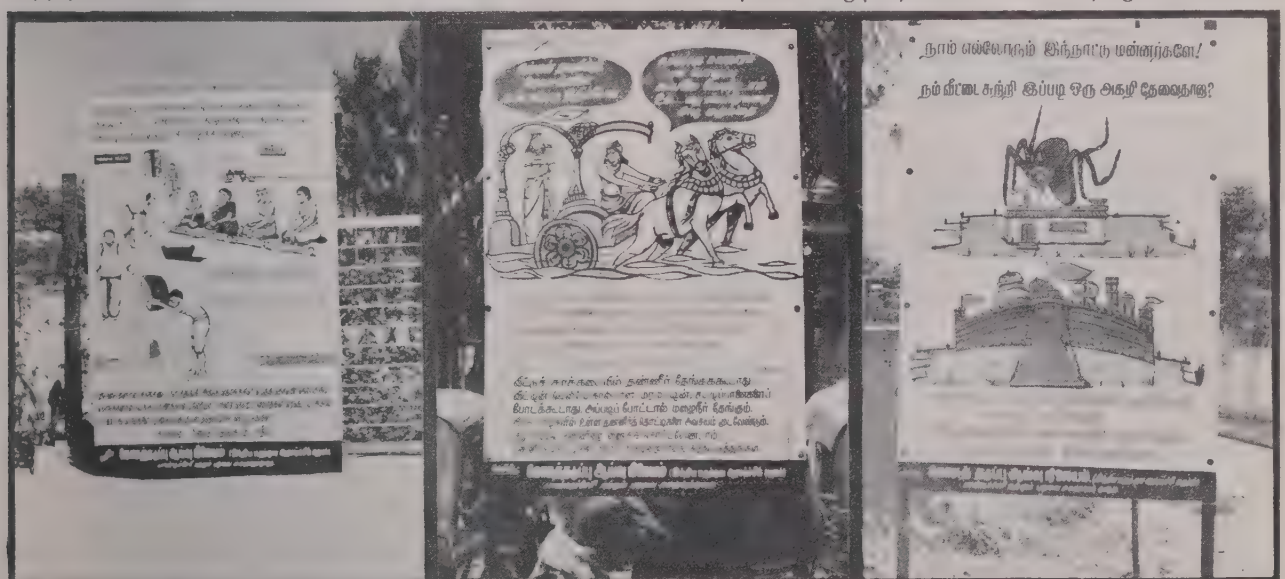
A fair idea of how things go wrong in a city from the point of view of filariasis can be seen from the study of Pondicherry conducted by the Vector Control Research Centre (VCRC) there. Pondicherry is full of breeding grounds for mosquitoes; an urban area of only 60 sq km in the city has 100,000 sq metres of cisterns and cess pools, 75,000 sq metres of drains, 5000 sq metres of cesspits, apart from over 4000 wells. Six major canals — in all about 10 km — carry sullage water from the town. Because of their wrong slope, some of these canals become large swamps of highly polluted water at the point where they join the sea. In addition, there are 80-90 km of feeder drains in which water stagnates because of the lack of desilting and deweeding. It is no wonder that the city breeds nine million mosquitoes in January, the peak month.

To a great extent, local politics is responsible for this breeding of mosquitoes; political rivalries in the management of the city have perpetuated the filthy conditions. Between 1961 and 1971, the urban jurisdiction of Pondicherry doubled and the population increased by 75 per cent. New colonies have come up in what were once paddy fields and coconut groves. But sewage disposal, which is a responsibility of the municipality, has failed to keep pace with the growth of the town.

In order to retain political support, local leaders continue to support construction of residential areas even on low-lying agricultural lands. "Unplanned urbanisation in the garb of so-called development is changing ecological conditions in a manner favourable for the spread of infection", lamented Dr V. Ramalingaswami while visiting the VCRC.

Yet, ironically, filariasis should be easy to control. If only the filth could be removed and the people and municipality ensure together that water does not collect in small, stagnant pools, the breeding of culicine mosquitoes can be brought down dramatically. These mosquitoes can even breed in water collected in small broken pots.

In a pioneering project the VCRC is trying to involve the



The Vector Control Research Centre has started a massive public education campaign in Pondicherry. Using popular religious stories, billboards urge people to destroy mosquito breeding sites in their houses.

community in Pondicherry to undertake such measures. Colourful posters, hoardings and cinema slides are being displayed all over the city. Regular reminders are sent to municipal authorities about neglected areas. Letters to newspapers are encouraged by outraged citizens. The outcome of this project, however, has yet to be reported.

CANCER

Health officials in most developing countries delude themselves by saying that cancer is not their problem. According to the WHO, more than half of the 36 million cancer cases in the world are found in developing countries. About eight million new people contract cancer each year and over half of them are in the developing world.

Cancer authorities believe that 80-90 per cent of all cancers are directly or indirectly environmentally determined. Sunlight, chewing various types of quid (tobacco, betel nut, slaked lime, etc), living and working environments, and personal choices of diet and ways of life like smoking and alcohol consumption, are major factors responsible for cancer.

Little is known about the exact incidence of cancer in India; there are no countrywide figures. Estimates prepared by the Greater Bombay Cancer Registry show that there are approximately 500,000 deaths from cancer annually. This means that nearly five per cent of all deaths in India every year are from cancer.

Three cancers — of the mouth, the cervix and the liver — chiefly affect Indians. According to Dr M.G. Deo, director of research at the Cancer Research Institute in Bombay, oral cancers (found both in men and women, but particularly in men) and cancers of the uterine cervix (found only in women), have the highest rate of incidence in India. These two cancers alone represent over one half of all cancer cases in the country.

Nearly 30 per cent of all cancers in India occur in the mouth and pharynx and are due to chewing of betel quid. Oral cancer is eight times higher among daily chewers as compared to non-chewers. The risks increase to 10 times if the chewing habit starts under the age of 15 years. Oral cancer patients are usually detected too late to be saved.

The relative frequency of oral cancer varies between different regions of India and so do tobacco and betel chewing

Antibiotic resistance

Too much of any good thing is bad. Today this adage has to be applied to no less than peoples most powerful weapon against— disease: antibiotics.

In less than 50 years of use, antibiotics are facing a crisis of confidence with bacteria all over the world rapidly becoming resistant to them — like mosquitoes to DDT. Ironically those who are to blame most for this state of affairs are the very guardians of these weapons: doctors. The World Health Organisation has called for an immediate end to indiscriminate prescribing of antibiotics by doctors.

Dr K.B. Sharma, dean of the Maulana Azad Medical College in New Delhi and a leading Indian expert on antibiotic resistance, says that he found resistant bacteria in 80 per cent of hospital patients and 65 per cent of staff he surveyed. He estimates that over 90 per cent of disease-causing bacteria are already immune to antibiotics.

Antibiotic resistance was first noticed in an epidemic form in Kerala in 1972, when some 3000 cases of chloramphenicol-resistant tyhoid were found around Calicut. It was soon discovered that antibiotics had been over-used during an epidemic of viral gastroenteritis amongst children which had started around the end of 1971. Although antibiotics are ineffective against viruses, they had still been prescribed on an unprecedented scale. A particular favourite of doctors was an unnecessary and irrational combination of two antibiotics, chloramphenicol and streptomycin — still available as a brand product but now on a list of drugs that the Government wants to ban. This excessive use of antibiotics resulted in a resistant epidemic of typhoid.

The typhoid epidemic itself subsided by the end of 1972 but the affected area of North Kerala has now become endemic for antibiotic resistant strains. In 1976 another epidemic of resistant typhoid occurred.

Since 1978, drug-resistant typhoid fever has been reported from other parts of India, including cities like Madras, Bombay and Chandigarh. This is not a case of the same infection spreading across the country. Each time it is a new focus of multiple drug resistance emerging.

Hospitals, where antibiotics are used freely, are probably the most unsafe places for newborn infants today. Protracted epidemics of antibiotic resistant infections — often tersely called "superinfections" — have been reported from many Indian hospitals with high fatality rates. An epidemic of drug-resistant bacteria which lasted in three Delhi hospitals from October 1975 to April 1977 claimed the lives of 237 children.

The spread of antibiotic resistance is a matter of major concern to India where diseases like dysentery, typhoid and cholera are common. In crowded, insanitary urban conditions, drug resistant strains of bacteria can spread rapidly.

Scientists are shocked not only by the speed with which bacteria have acquired anitbiotic resistance, but also by the realisation that virtually every type of bacterium found in the gut of human beings and livestock is capable of becoming resistant to antibiotics.

The obvious solution to this frightening problem is careful use of antibiotics. This will not only help to slow down the build up of antibiotic resistance amongst microbes, but also reduce the cost of therapy, which is important for the mass of poor patients in the Third World.

Doctors' lobbies point out that in India even vaids and various quacks are dispensing antibiotics. While this is true, qualified doctors themselves are to blame for the maximum misuse of antibiotics. These are prescribed for minor ailments like colds, diarrhoeas and mild coughs even when antibiotics are ineffective against them.

"We are forced to allow our primary health care workers to prescribe strong antibiotics in villages where doctors exist," says Dr Rani Bang, who works with a rural health care project near Wardha. "Milder antibiotics just do not work in those places anymore."

Behind all this overprescribing is also the hand of the drug industry, which builds up a strong sales pressure on chemists and doctors who are recompensed in a variety of ways. In a special campaign for an antibiotic, a multinational drug company allegedly provided chemists in India 48 vials free for every 52 vials purchased. An Indian company is reported to have offered stainless steel utensils for purchase of one of their drugs. A number of unsafe combinations of several antibiotics are also being marketed in India. The Government's efforts to phase out their production is running into strong opposition from their manufacturers.

Immediate steps can certainly be taken to ban the use of antibiotics in poultry feeds, as has already been done in countries like West Germany and Britain. Antibiotic resistance can easily be passed on to bacteria in human beings who consume poultry products. Researchers at the All India Institute of Medical Sciences in New Delhi recently failed to find an egg in the market that was not contaminated by antibiotics.

Pesticides and disease

Nearly 60,000 tonnes of pesticides are entering the Indian environment every year. About one-third of these pesticides are used for public health programmes while the rest are used against agricultural pests. BHC, DDT and malathion account for the bulk of the pesticides consumption in India. Public health programmes are almost entirely based on these three pesticides. They also make up over half the quantity of pesticides used in the agricultural sector.

Even though the use of DDT and BHC is restricted in many countries and these pesticides have been attacked by environmentalists across the world, they continue to be used in India in large quantities because of their low price. The average per hectare consumption of pesticides in India is still low when compared to consumption rates in USA, Europe and Japan. But nearly two-thirds of pesticides used for agricultural purposes in India are concentrated on two crops, cotton and paddy, and again nearly two thirds of the pesticides used are consumed in just 75 out of the approximately 400 districts in India. Pesticide consumption has been rising at about 12 per cent per annum.

The exact effect of these poisons on human beings or on the country's flora and fauna is little known. But a 1965 report revealed that the accumulation of DDT in the body tissues of Indians is highest in the world. Much of this pesticides intake appears to be through food. Indians may be ingesting 20-40 times as much DDT as Britons.

Surveys have shown high levels of pesticide residues on vegetables, fruits and cereals in the market. The contamination of wheat with parathion is reported to have led to about 100 deaths in Kerala in 1958. Some 250 villagers are reported to have been poisoned in another instance of wheat contamination by BHC during storage in UP. Although pesticide residues may be reduced by washing and cooking, even boiling removes only 35-60 per cent of organophosphate residues (eg malathion) and 20-25 per cent of organochlorines (eg DDT and BHC). Residues above tolerance limits can be found even in cooked food.

The National Institute of Nutrition in Hyderabad has reported a dramatic case of what is suspected to be the result of pesticide poisoning. In 1975, health authorities in the Malnad area of Karnataka reported a mysterious new disease. The first cases had begun to appear in 1969-70 and by 1977 over 200 people were affected in 40 villages. This disease was never seen in the region before. It began with intermittent pain in the hip and knee joints, which later became continuous until some people could hardly stand up.

The people affected by this disease — called Endemic Familial Arthritis of Malnad by scientists — were all poor harijans. At certain times of the year, especially when food is short, the poorer villagers would eat crabs caught in rice fields. At the time the disease appeared, there had been two major social and environmental changes. First, landowners had stopped giving food to labourers as part of their wages. And secondly, landowners had started using new high-yielding varieties of rice together with pesticides. The poor were, thus, on the one hand being pushed to greater reliance on paddy-field crabs for food and on the other hand, these foods were becoming increasingly contaminated with pesticides like parathion and endrin.

Apparently because of inbreeding and special genetic characteristics, the harijans of Malnad were particularly susceptible to these effects of pesticide residues. But the incident does show how closely dependent the poor are on their immediate environment and how harmful changes in it can be for them. The use of pesticides in paddy fields does mean that farmers who could breed fish for additional food can no longer do so.

The WHO estimated in 1972 that there are about 500,000 cases of accidental pesticide poisoning every year in the world, about half of which are in developing countries. WHO experts have also estimated that about one per cent of pesticide poisoning cases result in death in countries where medical treatment and antidotes are readily available. In countries without such facilities, the death rates are higher.

Around 40 per cent of pesticide poisonings are estimated to be from occupational causes, for instance, amongst anti-malaria sprayers or workers in pesticide factories. Few pesticide sprayers in India, either in the agricultural or the public health sector, use gloves or face-masks. A survey of farm workers engaged in spraying in Gujarat showed that they were not provided with face masks, only 50 per cent covered their nose and mouth with a cloth, and 20 per cent failed to wash after spraying.

Labelling is also often faulty. According to a report from a remote area in Tamil Nadu, the containers of a pesticide sold there by a multinational company gives safety instructions only in English and Hindi whereas the local language is Tamil. In any case, the common stipulation "in case of accident call physician" is almost a dirty joke in remote rural areas.

Often substandard pesticides reach the market. A survey by the Union Agriculture Ministry in UP, MP and Bihar found over half the pesticide samples to be substandard, including 45 per cent of those cleared by the Indian Standards Institution. Substandard pesticides can sometimes be even more toxic.

Often pesticides prohibited in developed countries have been sold to developing countries. In 1976, approximately 30 per cent of US pesticide exports were of products whose use is prohibited in the US. Leptophos, which is regarded by WHO is "extremely hazardous" has also been exported to developing countries, including India, under the brand name Phosvel.

habits. Whereas in the north a "quid" of tobacco is kept behind the lower lip, in the south quids of the betel are mixed with tobacco and kept behind the cheek. In the northwest people smoke small clay pipes while in several eastern areas about two million people, including women, smoke with the glowing end of the cigarette inside the mouth (reverse smoking).

The habit of chewing tobacco together with betel nut is believed to be the reason why oral cancer rates are higher amongst Indians than other ethnic groups. Chewing paan with betel nuts leads to cancer of the cheek and the incidence of this is usually higher in undernourished individuals. The WHO has pleaded for a ban on betel nuts in India.

Cancer of the uterine cervix mainly affects poor women and it is directly related to poor environmental sanitation and personal hygiene, early marriage, too many pregnancies and severe anaemia.

Industrialisation, increasing use of new drugs, agricultural chemicals, industrial poisons, changes in life-styles including eating habits, all these are increasing exposure of people to cancer-generating substances and hence to the risk of cancer.

Little data exists in India on how industrialisation and so-called modernisation trends have been increasing cancer risks. The problems faced by workers in mining industries, especially those dealing with coal and metals, are particularly significant. In recent years, there have also been some reported attempts to shift hazardous industries like asbestos production from developed to developing countries, where occupational health regulations are weak.

Similarly, cancer from long-term use of medicines, like oral contraceptives and tranquilisers, has caused considerable concern in the West. The Indian Council of Medical Research (ICMR) has drawn attention to two treatments used commonly in India — iron injections for anaemic patients and isoniazid in TB patients — which may be a cause of cancer.

Working is dangerous to your health

On an average working day in this country seven to eight workers die, and over 5000 are injured seriously enough to lose three or more days from work.

In the Mahatma Gandhi Memorial hospital located in the heart of industrial Bombay, approximately 19,000 workers (and their family members) were hospitalised over the year 1979 for a variety of complaints ranging from TB byssinosis, cancer and heart disease to accident injuries. Its death register records an average of 30 deaths a month. The MGM hospital is only one of the seven Employees State insurance Scheme (ESIS) hospital in the city.

In many cases accidents or extreme exposure to noise, toxic chemicals and gases result in acute, easily indentified illnesess. But most workers are exposed to low levels of these hazards, which may be justas deadly in the long run, though less apparent in the short run.

Low-level hazards cause chronic illness whose onset is often not noticed. The illness themselves, such as lung cancer and heart disease, are generally attributed to non-occupational causes by industry and the medical profession. They, therefore, go unrecognised, uncounted and uncompensated.

One of the major industries with glaring occupational hazards which has attracted some research efforts by the Central Labour Institute (CLI) and Bombay University's Department of Chemical Technology is the textile industry. It employs nearly 1.5 million workers all over the country, of whom over 800,000 are in cotton textiles alone.

A major occupation illness affecting textile workers is byssinois, a disabling respiratory disorder caused by inhalation of cotton dust over several years. Workers in the dustier departments of the textile mills such as the bale opening room, the card room, the blow room, and the winding and the spinning rooms show a higher incidence of byssinosis (popularly known as "brown lung"). In its advanced stages it results in "breathlessness on all days because of reduced breathing capacity leading to permanent incapacity" (that is in death), according to Dr Harwant Singh of the CLI. Dr Singh says that one in five cotton operatives probably has the disease is some stage of development.

Besides the ubiquitous cotton dust, there are serious chemical hazards involved in the extensive use of dyes and chemicals in textile mills. For example, inhalation of sulphur dioxide, sulphur trioxide, carbon disulphide, etc has been shown to increase the incidence of coronary diseases; it also brings about changes in blood chemistry and reduces the brain's ability to exert control over muscle movement. Excessive exposures can lead to fatalities.

Direct contact with acids, alkalis, detergents, solvents and resin precondensates used in the finishing department can cause immediate damage in the form of burns or can produce long-term complaints like dermatitis, eczema and other skin diseases.

Data from industrial workers suggest greater circulatory, heat and equilibrium problems in workers exposed to noisy environments. In most textile mills, the noise levels are above the danger threshold and have proven potential to cause permanent hearing loss. The workers in the spinning and weaving departments, whose number exceeds eight lakhs are the worst affected, says S. Purushothama of the CLI.

One of the most hazardous factories in Bombay is the 118-years-old Bombay Gas Company which supplies domestic cooking gas to some 30,000 consumers in the city. The plant uses an obsolete horizontal retort system for coal gas production and is reported to be in very poor shape. The fact over 25

INDIA TODAY/PRAMOD PUSHKARNA

workers have been killed in four major explosions between 1958 and 1978 speaks for itself.

Besides heat strokes (and heat strokes can kill), heat exhausation is common among workers toiling in high temperature areas such as the Retort beds where coal is heated to over 1100^{O}C. The worker suddenly feels a severe headache, thirst, dryness of mouth, together with mild fever.

A CLI study of respiratory diseases among Bombay Gas workers found that 24 per cent of them were suffering from chronic bronchitis, emphysema and active tuberculosis.

Besides gas, coke, coal tar and pitch are some of the other products of the Bomaby Gas Company. Epidemiological studies have revealed that coal tar and its derivatives cause cancer. In the US tar and pitch from gas works account for 70 per cent of all cases of tar cancer, states one study. While their are no similar studies on Bombay Gas workers, it is safe to suggest that the incidence of cancer among them will be similar, if not worse.

The predicament of mine workers is worse still, the black lung disease (pneumoconiosis) is found to be a common disease among coal miners. Thirty-five per cent of the population of coal miners surveyed by the Indian Medical Association in Dhanbad was suffering from ailments requiring medical treatment.

Asbestors miners are no better off. Asbestosis a cancerous disease caused by deposition of asbestos in the lungs is widely prevalent among them. Several miners are known to have died in Singhbhum, Bihar, due to asbestosis. Recently, this disease has been classified as a killer disease under the Factories Act.

Silicosis, another cancerous disease caused by deposition of silica in the lungs, is prevalent among the mica workers in Bihar. Although this is a fatal disease, there are no detailed studies to examine its prevention.

New food processing techniques are also increasing the risk of cancer. Inferior grade solvents which are often used to extract edible oils like groundnut oil have been shown to be carcinogenic. Argemone oil, which often gets accidentally added to mustard oil, is not a carcinogen by itself or even when added to pure mustard oil. But it does become carcinogenic when added to loose mustard oil in the market which also has various chemical impurities.

The poor often get cancer through improperly stored food like peanuts, maize and rice that get contaminated by

fungus. Aflatoxins, the poisons in these fungi, have been identified as an important cause of liver cancer in developing countries. Scientists at the National Institute of Nutrition (NIN) reported during the 1970s several cases of mass poisoning caused by aflatoxin-contaminated food.

Smoking and cancer

By far the most worrying phenomenon is the increasing use of bidis and cigarettes in India which could result in a dramatic surge in lung cancer. According to the WHO, smoking kills at least one million men and women every year in the world. Ninety per cent of all lung cancer deaths, 25 per cent of deaths from cardio-vascular diseases and 15 per cent of deaths due to chronic bronchitis are directly caused by smoking. The close association between the marketing practices of the tobacco industry and the increase in smoking, qualifies this form of cancer as a man-made "commerciogenic" disease.

In the 1950s cigarette consumption per adult in India was around 100; by the 1960s it had gone up to 200. Today 90 billion cigarettes are sold each year. In addition an estimated 100 million bidis are sold every day. Bidi smokers face a 10 times higher risk of getting cancer than cigarette smokers because bidis contain more poisonous and cancer-causing substances per unit weight, than cigarettes.

Despite these facts the Government has done little to control or reduce smoking because of conflicting loyalties: the needs of the exchequer and the health of the people. India is the third largest producer of tobacco in the world after the US and China. Apart from earning foreign exchange, tobacco and tobacco products provide a consistently increasing source of revenue. Revenue from tobacco. product increased from Rs 153 crores in 1967-68 to Rs 732 crores in 1980-81. It is in fact the most important source of government excise taxes.

The tobacco industry also generates vast employment. Bidi-making is a major cottage industry in India and provides jobs to millions of people, and in a large number of cases, it is the sole means of their livelihood.

About three-fourths of the tobacco produced is consumed within the country. About 78 per cent of the total consumption (for approximately 250 million kg) is in the form of cigarettes, cigars and bidis. Of the rest, about 20 per cent is chewing tobacco.

In recent years, the Government has been trying to take pressure off the cigarette industry by not increasing excise taxes any further. Consequently, last year, cigarette sales increased by six per cent. Having experienced an average annual growth of barely two per cent in the last several years, the tobacco industry is now planning for faster growth unhampered by new taxes.

Meanwhile, the Government's efforts to introduce statutory warnings on cigarette packets and advertisements about the health hazards of smoking are neither being enforced properly nor are they having an impact on smoking habits. When asked in Parliament in December 1981, Health Minister B. Shankaranand admitted that the enforcement of the law regarding these warnings was being reduced to a "mockery", but excused himself by saying that this was really a State subject. The Minister said that the Central Government now also wants statutory warnings on bidi packets.

According to the WHO there is probably nothing that could be done in the way of prevention that would have a larger impact at present than eliminating tobacco smoking and chewing.

Many developing countries have started taking strong measures against smoking. Kenya recently banned all smoking in public places. Even China, which promoted smoking during the 1950s and '60s, has now launched an anti-smoking drive.

To check the widespread suspicion that cigarettes sold in developing countries have a higher level of tar, nicotine and carbon monoxide, the WHO has sponsored an international programme to test cigarettes sold in the Third World. It is not only cheaper to produce cigarettes with higher levels of tar and nicotine but greater nicotine content also helps to keep smokers hooked on to cigarettes.

Strong measures are required in India to control the looming smoking-induced cancer epidemic. Glossy billboards depicting young men and women enjoying a casual puff while leaning on a late-model car, are, to say the least, a cruel social joke in a country with a per capita income amongst the lowest in the world.

Several leading health experts fear that even before malnutrition and communicable diseases are brought under control, developing countries like India could be overtaken by the spreading cigarette smoking habit.

India is in no position to carry the resulting double burden of disease, as Dr Ramalingaswami puts it. In order to combat the existing burden of poor health conditions characterised by insanitary conditions and malnutrition, it is important to keep under check any new and evolving burden of health problems because of unregulated industrialisation or modernisation spurred on by anti-social commercial trends. The thought of 900 million people in India suffering the same rates of cancer, heart disease and various smoking-induced illnesses by the year 2000 as those prevailing in developed countries, is appalling, especially when India does not have the expensive medical facilities or the manpower needed to deal with these diseases.

The world spends an estimated US $240 million a day on cigarettes. According to UN calculations, everyone in the world can be provided with clean drinking water and adequate sanitation if some US $80 million can be spent every day over the next 10 years. Nobody believes that the governments of the world can raise this "collosal" sum of money.

ENERGY

Cooking energy constitutes half of India's total energy consumption. No other form of energy use has greater impact on the environment or is more crucial for human survival. Yet the government has no national policy for supply of cooking energy.

Non-commercial sources of energy — firewood, cowdung and crop wastes — provide nearly 90 per cent of the country's cooking energy requirements.

No figures exist, but selling firewood may be one of the biggest occupations in India employing several million people. With landlessness growing, selling of firewood appears to be a growing occupation in most Indian cities.

Firewood scarcity in rural and urban areas is increasing dramatically. In mountainous Garhwal, women walk at least seven hours three out of four days to bring back 25 kg of wood each time. In many cities firewood prices have nearly doubled in the last six years.

For the most part, energy gathering of the poor does not appear to be a cause of deforestation. Their hearths burn mainly with little twigs, branches, leaves and whatever "kachra" that they can find.

India's energy resources are phenomenal but poorly organised. Depending on how much dung can be collected, biogas can meet the cooking energy needs of a third to nearly all the rural households of the country.

Fast-growing species planted along farm boundaries and on a fraction of the country's wastelands can meet all the cooking fuel requirements.

9

ENERGY

Mention energy consumption, and immediately thousands of industries burning fuel, millions of hectares of irrigated agricultural land, scores of trucks, buses, cars guzzling precious petroleum, come to mind. One can easily overlook the millions of gas, kerosene, wood or coal stoves that are burning in homes all across the country.

Half of all the energy consumed in India is in fact spent on cooking food; nearly double the energy consumed by agriculture and industry together. Energy planners often overlook this most essential energy need and planning priorities are always skewed in favour of the larger energy consumers. But in fact no other form of energy is more crucial for human survival or more sensitive to environmental conditions than energy for cooking.

Despite the massive development of oil and coal resources, non-commercial energy sources like firewood, agricultural wastes and cowdung are crucial for India's energy needs. Twenty eight per cent of the total energy consumed in India in 1975-76 came from firewood; that year the country burned 133 million tonnes of firewood. Another 73 million tonnes of dung and 41 million tonnes of agricultural wastes are burnt each year.

NON-COMMERCIAL SOURCES

For cooking energy, these non-commercial sources are even more crucial, providing as much as 87 per cent of the country's cooking energy requirements. Coal and kerosene formed eight per cent of the total cooking energy consumption in 1953-54 and rose to a peak of 14 per cent in 1970-71. After the oil price rise in 1973, this dropped to 13 per cent in 1975-76.

Another common fallacy is that firewood, coal, dung, agricultural wastes, are mainly used in the villages. But as much as 56 per cent of the energy consumed in cities comes from non-commercial sources. A majority of households in town and cities—73 per cent—are dependent on non-commercial cooking energy sources, reports the working group on energy policy set up by the Planning Commission. In villages the percentage of households partially or fully dependent on such cooking energy sources is 99 per cent.

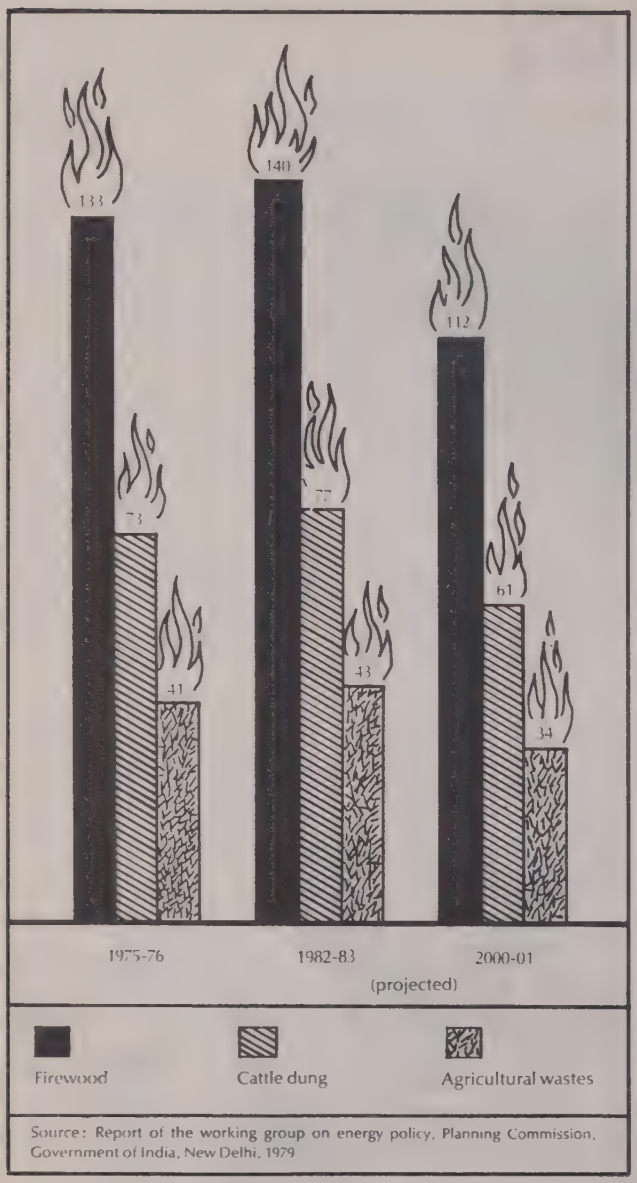
Firewood, the primordial fuel, thus remains the major source of cooking energy in India providing 50 per cent of the cooking energy in cities and 70 per cent in villages. The rapidly rising prices of alternative fuels like coal and kerosene, accompanied by the increasing denudation of forests (and decreasing supplies of firewood) implies that people will find it progressively difficult to meet their basic energy requirement—for cooking

The rise in prices of commercial and non-commercial fuels is creating further hardships. Between 1970-71 and 1980-81, whereas the per capita income rose by 143 per cent and the wholesale prices of all commodities by 150 per cent, the wholesale prices of commercial fuels—power, light and lubricants—rose by 264 per cent. Non-commercial fuels like firewood were not exempt from this marked price rise. In recent years, firewood prices have inflated so rapidly that in many cities they have nearly doubled in the last six years.

This enormous dependence on firewood has resulted in demand far outstripping supply. In Uttar Pradesh, for instance, only 18 million cubic meters (cu m) of firewood were produced in 1978 against a demand of 42 million cu m; by 2000 it will be 63 million cu m. According to a study published in 1977, 30 out of 45 districts in Madhya Pradesh—after taking into account the gross forest area and human population—are already suffering from a firewood famine. At the present rate of demand, forests in all but 16 districts of the State would have disappeared in another 20 years.

Firewood is the major cooking fuel in India. The rural poor mainly top off branches and twigs for their use, which does not lead to deforestation. (Earthscan/Mark Edwards)

Figure 1. Consumption of non-commercial fuels in the household sector (in millions of tons).



Source: Report of the working group on energy policy, Planning Commission, Government of India, New Delhi, 1979

Rural energy snapshots

Little is known about how exactly people are meeting their basic energy requirements in such dire circumstances. But some snapshots presented by various researchers in the last couple of years show that for the vast majority of the country's population, the cooking energy crisis is already here.

- In hills and plains, women and children spend a large part of their time travelling long distances to collect fuel. In village Dwing, in the high Garhwal Himalayas of UP, women walk at least 10 km three out of four days for an average of seven hours per day to bring back about 25 kg of wood with each headload.
- In Pura village, Karnataka, each firewood-gathering family spends 2.6 hours daily, travelling an average distance of 4.8 km. Children become the unwitting victims of the continuing energy hunger in the village as their time is taken up in fuel-gathering tasks. Education is the most obvious casualty.
- An extreme example of the difficulties faced in the villages is Vajeghad in Banaskantha district, Gujarat. With scanty rainfall and no irrigation, the area surrounding the village has become a vast, treeless plain. Women here spend six to nine hours collecting water and firewood out of a total working day of 14 to 15 hours. This includes two treks a day to the well, about two kilometres away. Another five kilometres are traversed to collect shrubs for domestic fuel.
- Even rich villages have their energy-poor as can be seen in Navli, a prosperous village situated close to the Amul Dairy in Gujarat. Irrigation, cash crop farming and animal husbandry have made several families in Navli very rich. But with firewood supplies dwindling and prices of imported firewood rising, farmers with large numbers of cattle have set up biogas plants and large landowners have started collecting their crops residues for use as fuel. So even though availability of cowdung and crop residues has increased in the village, those who have no land are facing increasing hardships. They are now totally dependent on the landlords. As one poor woman in the village laments: "There isn't enough money for food, so where is the question of buying firewood? We sometimes uproot small plants from around fences. When we are caught, we are fined. We have lost our livelihood and, it seems, our lives too."

To what extent these isolated scenes of rural India add up to a true and total picture of the situation across the country is difficult to say. Such studies of India's energy economy are rare and knowledge of trends even rarer. But it can be assumed that many millions of poor rural women in this country are caught in a vicious energy cycle: they eat food to get human energy and then spend all of this energy in producing food and collecting the energy needed to cook it. There is little else left in their lives.

Cooking in cities

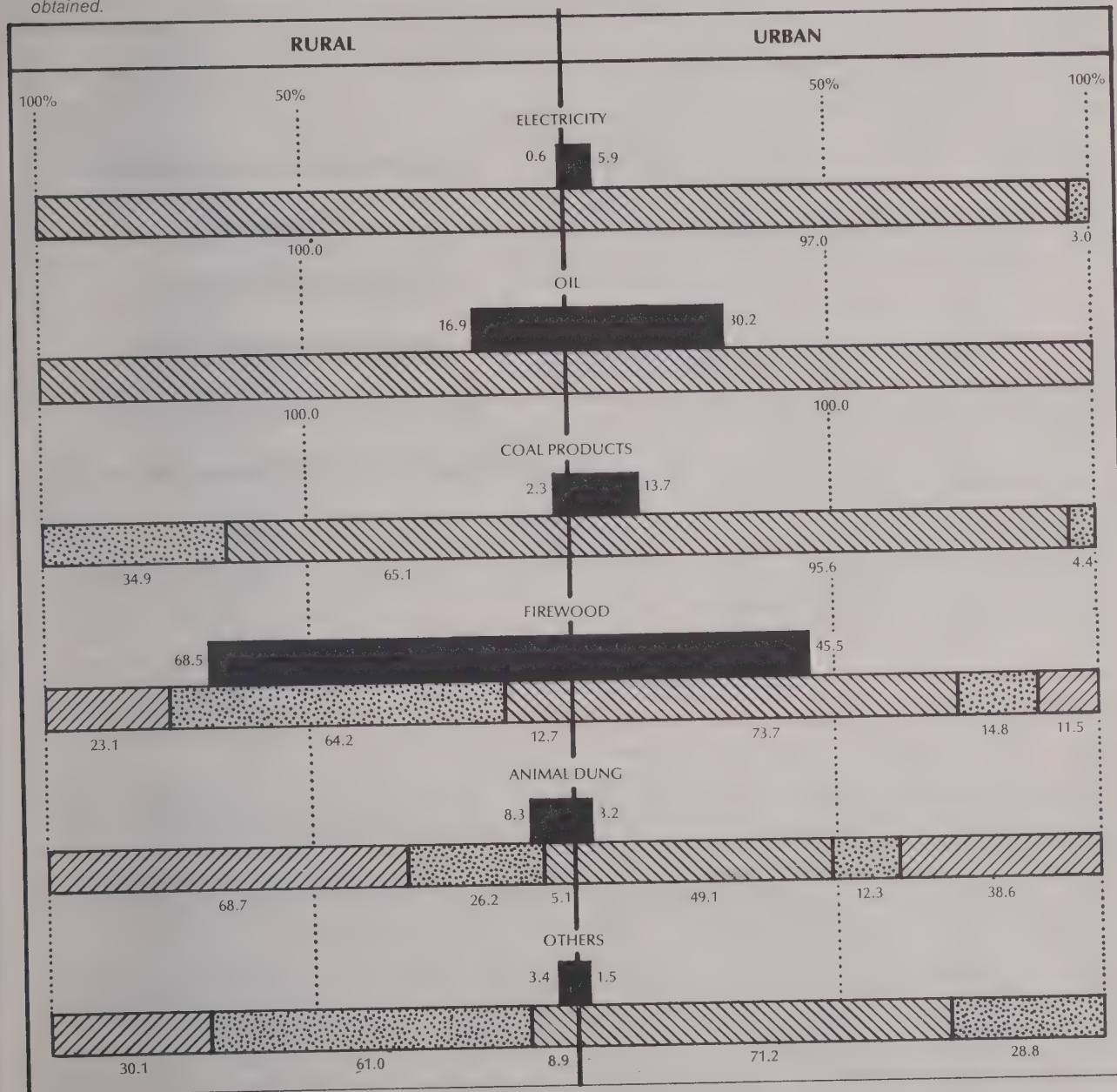
There is an even greater dearth of studies that describe the situation of cooking energy supplies in urban India, especially outside metropolitan centres.

According to available statistics, nearly three-quarters of

Dwindling supplies have made firewood a lucrative commodity. Every year millions of tons are brought into cities, weighed carefully and sold. (Earthscan/Mark Edwards)

Figure 2. Forms of energy consumed in rural and urban households and how they are obtained.

The ratio of commercial to non-commercial forms of energy in domestic use (based on per capita figures and conversion to coal replacement measure) is 20:80 for rural areas and 49:51 for urban areas. There are differences in the relative importance of different forms of energy and in the methods by which they are obtained.



Source: Report of the Working Group of Energy Policy, Planning Commission, Government of India, 1979.

firewood and about half of dung used in urban India are purchased. A substantial part of this firewood is brought in from the villages to be sold in the cities, though nobody really knows how much. Thousands of headloaders bring firewood to Ranchi everyday from nearby villages. All the three daytime trains from Dhronachalam to Kurnool in Andhra Pradesh bring with them a garland of firewood bundles strung outside carriage windows. In Kurnool, these trains are known as "Firewood Specials."

Recent studies at the Indian Institute of Science in Bangalore show that the city draws in nearly half a million tonnes of firewood every year and most of it comes on diesel trucks instead of trains, bullock carts or as headloads. Considering that most wood stoves or chulhas have an efficiency of only 5-10 per cent, it may not be surprising if more petroleum-based energy is being spent on transporting this firewood than it ultimately gives to the consumer.

Data collected in the 28th round of the National Sample Survey (1973-74) indicates that both in urban and rural areas, the poorest (spending less than Rs 21 per month per capita) consume hardly half the energy consumed by the richest (those spending over Rs 75 per month per capita). In cities, energy consumption patterns are even more skewed; the urban poor consume hardly 40 per cent of the energy used by the highest income group. How the poor in cities compare in energy consumption with the rural poor has not been documented.

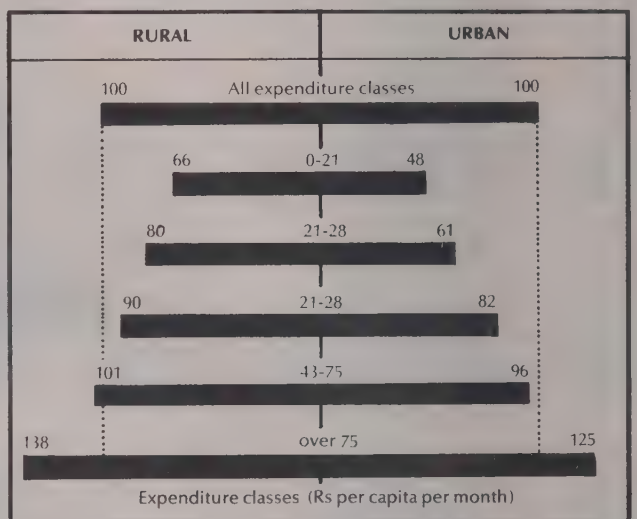
Although the Government has been pushing liquid petroleum gas (LPG) in metropolitan cities, its supply remains restricted to the upper middle class and the demand far outstrips the supply. In towns, kerosene is the main fuel for cooking. It is likely that a greater number of people in cities will become dependent on kerosene for cooking now.

The survey on energy demand in Greater Bombay carried out by the National Council of Applied Economic Research (NCAER) in 1973 revealed that oil products—kerosene and LPG together—provide 75 per cent of the total energy consumed in the households of the city. Bombay's population, one per cent of the national population, used about 10 per cent of the kerosene consumed in the country. Kerosene was mainly used for cooking and for heating water. As an illuminant its use was found only among the low income groups and even here its importance is on the decline. The share of non-commercial sources like charcoal, firewood, dung and crop wastes had dropped dramatically from 40 per cent in 1958 to only about eight per cent in 1970-71 and was expected to drop further.

The erratic supplies of kerosene and LPG make it impossible for many middle class families to rely on one source of cooking energy. In Calcutta, where electricity supply is erratic, replacement of an exhausted LPG cylinder can often take as much as a month, the supply of kerosene is not assured, many families are turning to a fourth alternative: coal. But as new houses generally do not provide facilities like chimneys for burning coal, the use of "angithis" (coal stove) only means a lot of smoke and suffocation. Many landlords in Calcutta, in fact, extract promises from new tenants before they rent out their premises that they will not burn coal. Moreover, purchasing equipment to keep all four cooking energy options open is extremely expensive for most families.

There is still no study which describes what families at different levels of earning spend on meeting their cooking energy needs and how this is changing over time.

Figure 3. Income-wise indices of per capita energy consumption in rural and urban households



Source: Report of the Working Group on Energy Policy, Planning Commission, Government of India, New Delhi, 1979.

The cost of energy

In cities poor families spend a much larger proportion of their incomes on meeting their energy needs, often as much as 15-25 per cent of their total income. For a relatively prosperous family, the expenditure on cooking energy probably drops to less than five per cent of the annual income. Considering that poor families ought to spend as much as 80-90 per cent of their income on food, rising fuel prices will lead to reduced food intake. For an already malnourished population, this would indeed be unfortunate. Reports from Bangladesh, Nepal and Pakistan show that some poor rural families may, in fact, already be spending as much as a quarter of their incomes on fuel.

Cooking energy shortage will not only create serious nutritional problems but may also lead to increased incidence of various diseases. The FAO document "Agriculture: Towards 2000" points out that with fuelwood production expected to fall short by 40 per cent, "Many poor people will not be able to cook their food adequately. This can have serious nutritional and health consequences. The digestibility of food will decrease and the incidence of parasites ingested with insufficiently cooked meat will rise. There are reports of this happening already in some areas."

The already widespread incidence of scabies in India can certainly be attributed to inadequate supplies of water and fuel resources. Inadequate fuel to heat bath water during winter makes many poor people avoid baths for a long period, leading to scabies.

The obvious question at this stage is: how are the poor trying to meet energy crunch?

The Kurnool "firewood special". Firewood sellers, their wares tied to the carriage windows, crowd into the train (top). The train halts on the city's outskirts and the dealers stream out, heading for the nearest market. (The Hindu)

Who uses firewood?

There is now definite evidence which shows that villagers are trying to meet their energy needs by substituting one energy resource for another—firewood by agricultural wastes, for instance. Contrary to popular belief, recent studies reveal that firewood (especially firewood in the shape of logs rather than small twigs and branches) has become so scarce in many villages that it is now available mainly to the richer rural families.

Recent studies also clearly show that the bulk of energy consumption attributed to firewood comes mainly from twigs and branches. The poor seldom cut trees; they mainly lop off small branches, twigs, roots and dead-wood—a practice that does not lead to deforestation.

This picture emerges in graphic detail in the Pura study. As much as 96 per cent of the firewood used by energy-gathering families (that is, poor families) was in the form of twigs; the rest was small branches. In contrast, rich households who obtain their requirements from their own land depend upon logs and account for 19 per cent of the firewood consumed in Pura.

By arguing that twigs and to a lesser extent branches, can be obtained without cutting down trees, whereas the procurement of logs necessarily requires tree-felling, Professor Amulya Reddy and his colleagues at the Indian Institute of Science—the authors of the Pura study—reach the important conclusion that gathered firewood (upon which three-quarters of Pura's households depend) does not contribute in any significant way to deforestation. This data casts serious doubts on the widespread belief held by many environmentalists that the firewood demand of the poor is leading to extensive deforestation.

There is no study showing to what extent trees are being cut for firewood as compared to tree-felling for commercial timber, clearing of land for agricultural purposes, construction of development projects like dams or for resettlement of refugees and urban growth. The available evidence indicates that the latter is probably a far bigger cause of deforestation.

Actually, there may even be a male-female dichotomy on the deforestation issue. Amongst the poor, it is women and children who collect firewood and they are seldom involved in logging operations. They generally collect twigs and branches. But men, who are interested in cash, are more capable of chopping trees for sale.

In fact, if the energy-gathering families of India were indulging in deforestation, considering that most of the energy consumed in the rural areas is gathered, all trees should have disappeared by now. Indian foresters and energy experts do not even know how much wood our trees are yielding for fuel. As fuel needs could be met conveniently from branchwood and bark, the growing stock (which only takes into account timber), would be higher than the figures available in the country for purposes of assessing the fuelwood resources.

However, the biggest threat to forests because of fuelwood needs is imminent. The growing trend towards commercialisation of firewood probably poses the most serious threat. The results of the 1973-74 national sample survey as compared to the 1963-64 survey showed that non-commercial fuels were fast becoming commercial in urban

FIREWOOD IN THE LIFE OF PURA

Pura village in Karnataka consists of 56 households:
- — 2 of these purchase their firewood;
- — 2 get theirs from land that they own;
- — 9 gather some firewood and get the rest by other methods;
- — 43 households—or over three quarters—get all their firewood by gathering.

Each year, Pura consumes 216,738 kg of firewood:
- — 7943 kg (3.7 per cent) is purchased;
- — 34,142 kg (15.8 per cent) comes from the users' own land;
- — 174,653 kg (80.5 per cent) is gathered.

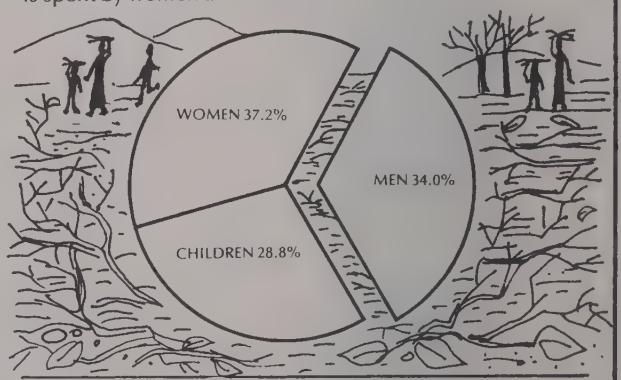
On average, then, each person in Pura consumes 614 kg of firewood in a year—nearly 1.7 kg every day.
The average household uses 10.6 kg a day.

Most households depend on more than one kind of firewood. How many use the various different kinds, and how do they get them?

	Gathering	Purchase	From own land
Twigs	48	3	0
Branches	42	3	5
Roots	6	0	0
Logs	0	0	5

The people of Pura get most of their firewood by gathering—174,653 kg a year:
- — 169,093 kg (96.8 per cent) of twigs and branches;
- — 3536kg (2.0 per cent) of roots;
- — 2024 kg (1.2 per cent) of other forms.

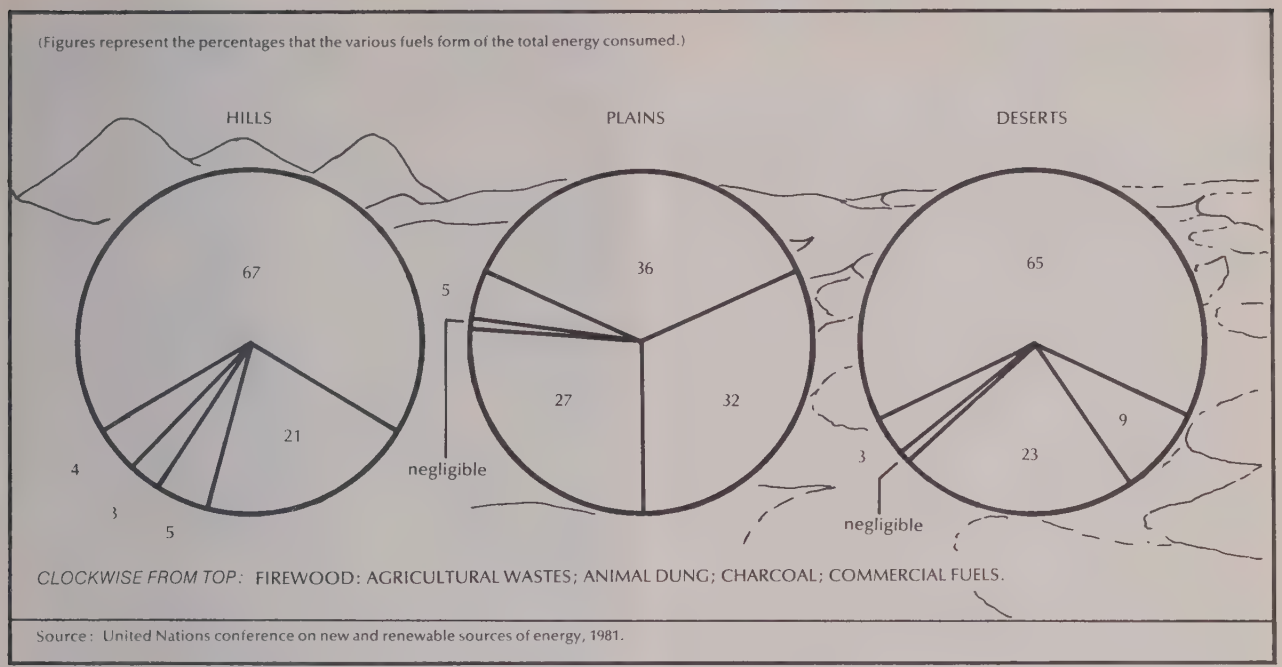
A great deal of time and energy is spent in the gathering of firewood—a total of 47,642 hours a year, two thirds of which is spent by women and children.



On average, each household makes 172 trips a year to gather firewood, travelling over 8.5 km over on each round trip and spending over 2.5 hours every day on this task.

Source: Rural energy consumption patterns — a field study. Centre for the Application of Science and Technology to Rural Areas, Indian Institute of Science, Bangalore.

Figure 4. Patterns of consumption of energy for domestic use in the rural areas of northern India in 1975-76.



Source: United Nations conference on new and renewable sources of energy, 1981.

areas and a similar trend, though at a slower pace, was also observed in rural areas.

The cooking energy demands of the relatively rich, living in small towns and on the fringes of the metropolitan cities, who cannot afford or get commercial energy sources, will create a major demand for gathered energy sources like firewood. The headloaders of Ranchi and the "Firewood Specials" of Kurnool are fundamentally responses to this demand. In the process, the landless poor, whose numbers grow everyday, will hope to earn a pittance of a livelihood.

The pressure on trees also differs between various ecological regions. Families in the hills not only consume 25 per cent more energy than in the plains, they also consume more firewood: 1573 kg versus 787 kg. In desert and hilly regions, where agricultural production is low, people depend more on firewood. As much as 65 and 67 per cent of energy consumption respectively, is met by firewood. In the plains, its contribution drops to 37 per cent and that of crop residues goes up to 31 per cent. This shows that in desert areas, where vegetation is sparse, firewood is the most important source of energy consumption: an ecologically disastrous situation.

Where crop residues are available people use them, easing the pressure on trees. But where agricultural growth is stagnant, people will turn increasingly towards available trees,a situation that villages in Bihar, for instance, may face increasingly.

Fuel-less poor

Increasing numbers of landless and marginal farmers pose a serious challenge to any national plan aiming to increase people's energy standards. In 1977, an estimated 24 million households with a total population of 114 million, had less than one acre of land. With declining firewood resources these people will become more dependent on cattle and landowners for their fuel needs. In such circumstances, any trend towards commercialisation of fuels like dung and plant-residues or introduction of technologies like biogas plants that permit land and cattle-holding families to make use of these resources themselves, will seriously affect the landless poor. They could easily find themselves in a situation of energy scarcity amidst energy plenty, where the gap between the energy rich and the energy poor increases.

While there is considerable literature about the concentration of land and cattle-holdings, is it is possible that the concentration of tree-holdings may be even more skewed? A study from a Bangladesh village—the only once available of this kind—shows that 16 per cent of its families owned 55 per cent of the cropped land and 46 per cent of the cattle-holdings but they owned as much as 80 per cent of the trees and they tood a keen interest in protecting them.

With changing feudal relations—the old patron-client relationship in which the landlord took care of the needs of his agricultural labourers—rapidly disappearing under the onslaught of the cash economy, it can be easily expected that the new farmers will leave the village poor to fend for themselves. Thus, even if biomass energy increased in the village, the poorest families may find that in periods of scarce employment in the village or high demand for wood in the towns, there is no better livelihood than to collect some wood and sell it (regardless of what happens to the environment), while scrounging around for some plant-wastes by the roadside for their own chulhas.

Two industrial consultants recently wrote an interesting report in "The Economic Times" about the changing use of agricultural wastes in Gujarat, which more or less supports the above scenario. These consultants were asked by their client to investigate why the process developed by the Cotton Technology Research Laboratory (CTRL) in Bombay to manufacture particle boards from cotton stalks—a major

Women and energy

Why is it that almost every effort to involve rural communities in accepting new energy technologies, like improved woodstoves, community biogas plants or fuelwood plantations, has failed?

Though the causes of failure will certainly be many, one important factor is that women are rarely involved in these projects. When they are consulted the evidence is that the success rate is high. Men seldom collect or use cooking energy and are therefore least interested in either spending their labour or the family cash resources under their control on service technologies that hardly concern them.

Just by doubling the energy efficiency of woodstoves (chulhas), which is a miserable 5-10 per cent at the moment, the country can halve its present firewood consumption to about 75 million tonnes. More important, women would save hours which they spend on firewood collection.

Though many past efforts to introduce improved woodstoves have failed, one design that has caught on is the Nada Chulha, the creation of a young architect from Chandigarh, Madhu Sarin. She resolved to redesign the chulha when she saw a woman in Nada village literally suffocating from smoke in her house as she attempted to cook on the traditional stove.

Working exculsively with the women of Nada, Sarin designed a stove that has a chimney which allows the smoke to escape outside; a damper between the chulha and the chimney controls the air flow. The stove lights with ease and the women find they can boil 12 litres of water with the same amount of wood as they did seven litres of water. The saving in fuel means one trek a week for firewood instead of two.

Interest in the improved chulha is now high in Nada and its neighbouring villages. Many village women have made further improvements to the stove. "My husband never did anything to improve the stove", says a Nada woman, "but he now forbids me to use the old smokey chulha." Several institutions in Punjab are now training women promoters to disseminate information on improved woodstoves.

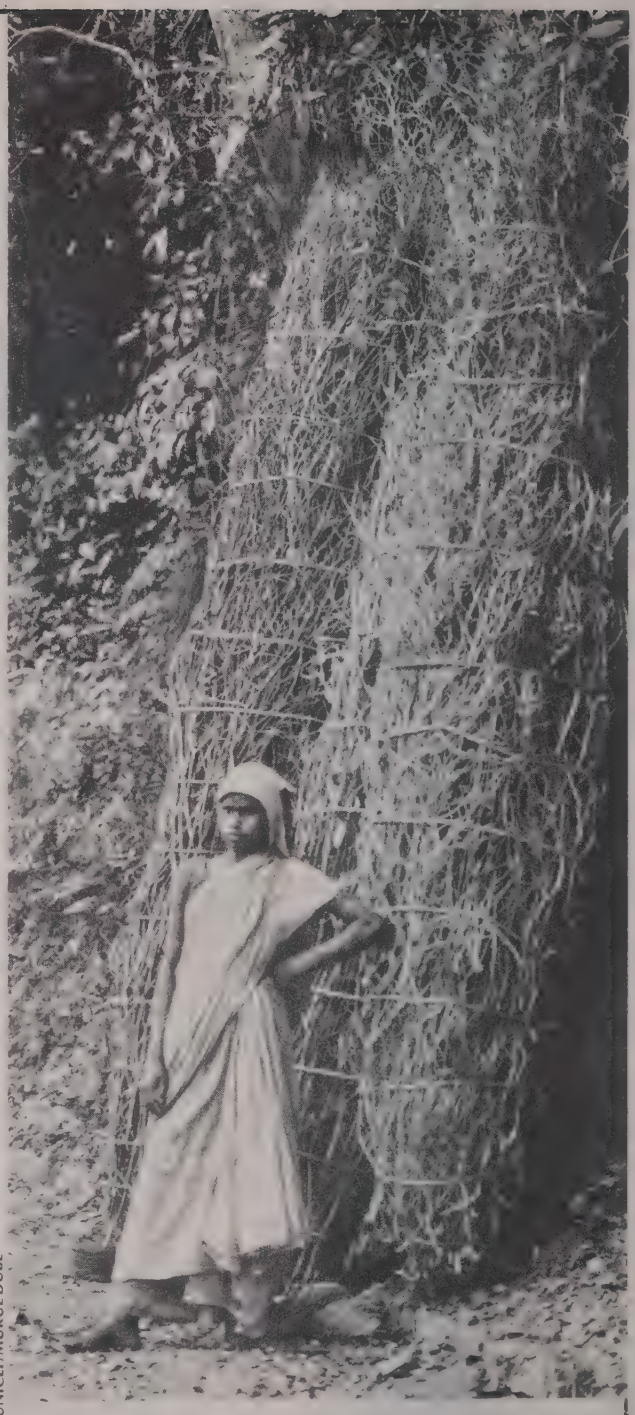
The sharp differences in the interests of men and women over trees are evident from the experiences of the Chipko Andolan volunteers in the Garhwal Himalayas. The Chipko activists have encouraged local villagers, through ecodevelopment camps, to plants one million trees, making it the country's largest voluntary afforestation programme. The survival rate of these trees is over 85 per cent as against 25-50 per cent in government plantations undertaken by contractors.

When the village assembly was asked to choose the trees to be planted, the men wanted fruit trees while the women argued in favour of fuel and fodder trees. "What will we get if fruit trees are planted," said the women. "The men will sell the fruits and purchase liquour or tobacco." In the end both types of trees were planted to retain the interest of men but it is women who have worked to ensure the survival of the trees.

Similar differences were found amongst men and women in another ecodevelopment camp organised in a desert village in Jodhpur district. Not surprisingly, when the forest department there was approached for saplings, it had only fruit trees or trees which yield commercial timber, both being trees that yield cash for men. Women of the hill town of Gopeshwar, where the Chipko Andolan started in 1973, are now urging that women should be elected to forest panchayats — village councils that manage community forests.

Meanwhile Professor Amulya Reddy and his colleagues at the Indian Institute of Science in Bangalore are also realising the special interests of women in cooking energy systems since they began building a community biogas plant in Pura village. "Our plant has been delayed by a year because we have had to design a new and cheaper gas burner. While the men have lost their curiosity and interest, it is women who keep asking us when will the plant start. This special interest amongst women has come to us as a bolt from the blue," says a surprised Reddy.

The male community leaders in Fateh Singh Ka Purwa, where two community biogas plants came to a halt after operating for a year, expressly state that cooking energy is not a priority for them. They much prefer energy for running threshers and tubewells.



UNICEF/MUKUL DUBE

crop residue in Gujarat—had not been widely used even though wood has become expensive. The consultants visited three tribal villages: Goral, Kanpur, and Choriwad.

With wood becoming expensive, the poor tribals rely on cotton stalks as fuel. But a big farmer admitted that he had been selling cotton stalks to agricultural labourers, a new trend in the region. The consultants concluded that the CTRL's assumption that cotton stalks are a freely available waste is not true.

ALTERNATIVES FOR COOKING ENERGY

Among the resources and technologies available for increasing cooking energy supplies and their potential role within the country are firewood, cowdung, crop residues and solar energy.

Firewood

Firewood is obviously the most important cooking fuel and will probably remain so for a long time. India's current consumption of firewood per year is an estimated 133 million tonnes. While there has been a tremendous concern about production of food in the past, the matching need to cook food has been overlooked. Cooking of one kg of food requires 1.2 kg of fuelwood. Therefore, fuelwood production must actually exceed that of food production in India and the two must be integrated.

The area under forests is no indicator of the quantity of wood available in the forests. Of the total area of 75 million hectares under forests, 54.6 million hectares (60 per cent) are in use and another 14.8 million hectares (20 per cent) are potentially exploitable. The rest are said to be unexploitable. Indices like "growing stock" and "mean annual increment" depend on the nature of the forest, the varieties of trees in the forests, etc. Growing stock estimates range from 901 to 2089 million tonnes. The most optimistic forecast made for the country as a whole implies an average growing stock of about 28 tonnes per hectare only.

All these estimates of growing stock have been made with reference to timber production only, therefore they set out the growing stock in the terms of volume under bark and exclude the wood from branches. A rough estimate places the annual yield of wood for fuel purposes from forest land alone to be over 73 million tonnes.

No attempt has been made to collect systematic data on the growing stock of wood outside the forests. In 1965, a survey covering 0.97 million hectares of non-forestland found a growing stock of about 7.5 tonnes per hectare. Even if the growing stock in non-forest-lands is assumed to be about half of this estimate, the total growing stock should be about 920 million tonnes, with an annual increment yielding about 30 million tonnes of fuelwood.

Thus, together, India's forest and non-forest lands are at best supplying 103 million tonnes, yielding a deficit of about 30 million tonnes. But these estimates are only rough guesses of the fuelwood supply position. They show with certainty the current unproductiveness of our lands. Contrary to popular belief, there is no dearth of land in the country to produce even two to three times our fuelwood requirements. If there is a shortage, it is of political will, funds and organisation.

Sources for fuelwood

The first major source of fuelwood can be our farm lands. Trees can be grown on farm lands as shelter belts, wind breaks, shade trees, fodder trees and fruit trees, and all these will provide fuelwood. Assuming that a family of five will have a fuelwood demand of around 1.125 tonnes per annum (with 20 per cent of its total energy demand being met by vegetative wastes), a farmer will have to grow 50 such trees to harvest 10 trees on a five-year rotation. One fast growing tree should yield between 100-125 kg of fuelwood at five years of age. At a spacing of about two metres, 50 tall straight-growing trees which do not give shade (like poplar or eucalyptus), can be planted around the boundary of a farm of about one acre (0.4 ha). Generally, therefore, even a small farmer can conveniently grow a sufficient number of trees to meet the family's fuelwood requirement. If such a scheme were implemented, cowdung would then be released for use as farm yard manure, boosting agricultural productivity and counter-balancing any reduction in area under crops that may take place. A rough estimate yields 96 million tonnes of fuelwood from such farm-belt plantations.

The major management problems of farm forestry are mainly technical and institutional. Appropriate tree species need to be carefully chosen so that competition with agricultural crops is minimal. Farmers will have to be motivated through training, demonstration, advice and incentives to incorporate quick-growing fuelwood producing trees in their farming practices along with fruit and fodder trees in order to meet their fuel needs.

Fuelwood from waste lands

The second major source of fuelwood can be the vast tracts of barren and waste lands amounting to nearly 80 million hectares, which are idle at the moment and including about one million hectares along the country's roads, rail lines, canals and drains. This entire land may not be available for tree planting as large areas have been encroached upon for various purposes. Even if 15 per cent of the country's barren and waste lands can be planted with fuelwood species, there would be 12 million hectares of land under fuelwood plantations. These lands would yield about another 96 million tonnes per annum, assuming an annual yield of eight tonnes per hectare.

Two biomass research centres set up by the Department of Science and Technology, at the National Research Institute in Lucknow and the Kamaraj University in Madurai, are investigating a variety of tree species that can give high yields in saline and alkaline lands. For example, in the Kutch district of Gujarat, with a total area of 3.2 million hectares of barren and unculturable land, energy plantations of prosopis and other species can be easily raised.

The third major source of fuelwood can be the degraded forest lands. Proper protection of the degraded vegetation supplemented by afforestation, can provide, even with the low annual yield of six tonnes per hectare, a fuelwood production of about 50 million tonnes every year. Thus, even by conservative estimates, the Planning Commission fuelwood study committee calculated that some 242 million tonnes of fuelwood can be produced every year.

Focus on fuel

Doubtless, a massive effort will be required. First the focus of forestry practices will have to change from production of timber to production of fuel and fodder. Fast-growing species will have to be selected for each agro-climatic region. Then care will have to be taken to provide a good soil-moisture regime to the growing tree, especially in the establishment phase from the seed to when it is about three metres in height. A total agro-technological package will have to be standardised for each species in each agro-climatic regime.

Some of the fast-growing tree species like leucaena (ipil-ipil or kubabul) have a dramatic response to the soil moisture regime. Experts of the recently set up Society for the Promotion of Wastelands Developditions, in the same soils, the yield of leucaena can vary as much as 17 fold: from three tonnes per hectare per year, under fair moisture conditions, to as much as 50 tonnes under irrigation. Therefore water conservation techniques must become an integral part of every social forestry programme.

Substantial financial resources would be needed. This entire programme would have to be supported with an annual budget of Rs 800 to 1000 crores at least. It will, however, not only create massive fuelwood assets for the country — 96 million tonnes every year—but will also generate employment to the extent of 300-500 mandays per hectare of plantation activity for the first three years in the rural areas. Later, the harvesting of the forest would provide employment at an ever higher level of income.

Secondary employment opportunities in the processing of wood and other forest products would help in creating employment for many more millions of people. The three million hectares to be covered under social forestry programmes during the Sixth Plan— which will yield an estimated 24 million tonnes of fuelwood per annum—are clearly not adequate to meet the fuelwood requirements of the country. The extensive programmes suggested by the fuelwood study committee need to be taken up urgently.

The working group on energy policy, while making its projections for firewood demand in the country, had assumed that the rate at which commercial fuels were replacing non-commercial fuels in the past, would continue. They estimated that from 1982-83 the absolute level of non-commercial fuels used in the country would diminish slowly despite population growth. The non-commercial energy used in the household sector would drop from the current share of about 80 per cent to about 50 per cent by the year 2000.

However, there is no evidence to show that this scenario will hold true. It is more likely that scarcity will force people to reduce their consumption of cooking energy or look around for more agricultural wastes and whatever little shrubs and twigs that can be gathered around. If the share of non-commercial energy in the household sector were to remain the same in the year 2000 as it is today, it would mean an increase of firewood demand from 133 million tonnes to about 180 million tonnes.

However, if firewood supplies do not increase over the 1974-75 figures, neither do the supplies of animal dung increase because of a stagnant animal population, an enormous pressure would build up on agricultural wastes to yield energy. This will have a tremendous ecological effect in terms of growing soil infertility, reduction of tree cover, soil erosion, floods, etc. Simultaneously, the oil bill will continue to increase affecting the country's trade balances adversely. All this underlines the paramount importance of taking up fuelwood programmes in a major way.

A debatable question

There is still one big matter that remains open for debate: should this be done directly by involving people in community forestry programmes, whereby fuelwood resources are grown directly and shared by the people, or should it be done in a roundabout manner by turning wood into a lucrative economic commodity so that massive tree planting programmes will be taken up by agroforestry entrepreneurs, thereby increasing the country's tree cover and hopefully fuelwood resources as well?

This is a question that the country's social and political sections will have to answer. Do we have the will to create conditions in which millions of rural people can participate in the creation of community assets? If we have the will, how exactly are we going to do this? What is the nature of the forces that obstruct such efforts? All these are social and political questions that still have to be fully understood, if the first approach is taken to creation of massive fuelwood resources.

On the contrary, the second approach may be easier. The danger of such a scheme, however, is that it would immediately commercialise rural fuels, which, as we have seen in the above paragraphs, could further reduce the accessibility of those poorest groups who are just about making two ends meet.

Cowdung

Just as there is an explosion of interest in fuelwood plantations and social forestry at the moment, there was an explosion of interest in biogas plants during the mid-1970s, after India witnessed the first shocks of the oil crisis. The working group on energy policy proclaimed that "biogas plants constitute the most promising alternative energy technology in the household sector".

The Government has encouraged biogas plants since the Fifth Five Year Plan. But despite subsidies and bank loans just about 100,000 plants have been installed. Even the most recent target of about 100,000 plants every year appears unrealistic to most observers.

Small family-size biogas plants that have been promoted in India increase inequality between energy haves and have-nots. As only about 10 per cent rural households possess four to five head of cattle, the minimum needed to feed a family-size plant, these plants prove useful only to richer farmers. Moreover, by using the cowdung for their own needs, these farmers deprive the poor of a fuel that does not have any price at the moment and is freely available. These criticisms notwithstanding the agencies promoting biogas plants have not been able to reach even one per cent of their potential market in the last six to eight years.

There are several reasons for this failure. For instance, the cost-benefit of these plants to the consumer has not been reckoned with properly. The cost of thermal energy generated by a popular 1.68 cubic metres per day Khadi

Nine out of ten rural households cannot afford family-size biogas plants. Cowdung cakes are the commonest form of this energy resource. (Earthscan/Mark Edwards)

Village Industries Commission (KVIC) model is equivalent to purchasing firewood at 20 paise per kg — which is not an attractive incentive to poor families. The Janata model developed by the Gobar Gas Research Centre at Ajitmal, in Uttar Pradesh, based on Chinese designs, is cheaper. But the KVIC is more interested in promoting its own costlier model. However, some 700 Janata plants have been set up in U.P. and Rajasthan.

Community biogas plants

To overcome the problems of inequality created by family-size plants, several biogas proponents have advocated community-size plants. Substantial economies of scale make the large community plants a much better investment. A community plant for 56 families is only 6.3 times the cost of a plant for one family. But the cost of distribution to households is high, making up a substantial part of the total cost of the plant.

Few community plants have actually been set up, since the collection of manure and distribution of gas pose social and organisational problems. Hardly any such biogas plant has run for a long period. The only two community plants which have operated for over a year, were set up in Fateh Singh Ka Purwa in Etawah district by the Gobar Gas Research Centre in 1978 — one plant for cooking and another for generating electricity. The village had an adequate number of cattle per head to supply the cowdung. Although the two plants provided electricity and cooking gas to every family in equal measure, the villagers lost interest and stopped supplying the cowdung.

Even though cooking energy and its collection is almost exclusively the domain of women, and women in Fateh Singh Ka Purwa were neither consulted nor involved in operating and maintaining the plants, even by their own men, the acceptance of community plants seems dependent not only on social and economic relationships operating in a village but also on the male-female power relationships operating within the families of the village (see box) — an area as yet little understood or adequately appreciated by social scientists.

Biogas potential

The exact potential of biogas plants in India is a matter of speculation, but nonetheless very high. According to a study of the Department of Science and Technology, India's 237 million cattle (1972 cattle census) can yield 575 million tonnes of usable dung per annum. This dung can produce about 22, 424 million cubic metres of biogas — sufficient to meet the cooking needs of about a third of the total households in the country. But assuming improved health of the country's cattle population and, hence, more dung, and better collection efficiency of the dung generated, Planning Commission experts have calculated the biogas potential to be sufficient for the cooking energy needs of all the rural households. (See box).

There is, thus, really no dearth of biogas resources in the country. With current research in India and abroad to find vegetable wastes that could be used together with cowdung, these resources could be further extended. Water hyacinth has proved a promising supplement to cowdung. The Chinese already add vegetable wastes to animal wastes on a large scale. Finally, of course, there is the vast resource of human excreta which can also extend animal wastes substantially: every 16 families should be able to provide one family with all its cooking energy needs.

Besides providing valuable manure and hence improving soil fertility and increasing crop production, biogas plants are better from an energy point of view than burning cowdung. Assuming a conservative conversion efficiency for a biogas plant, it can provide as much as 25 per cent more energy than burning cowdung straight.

The Injambakkam example

A study conducted by the Murugappa Chettiar Research Centre of Madras, using data from the coastal village Injambakkam (Tamil Nadu), shows that the installation of a biogas plant together with a fuelwood plantation, could turn the village into a net exporter from a net importer of fuels within 10 years.

After the commissioning of the community biogas plant, its slurry, which has approximately twice the quantity of usable nitrogen as compared to spreading cowdung directly on the fields, will tend to increase the rice crop. The extra rice straw can be fed to cattle, further raising dung production in the village. This in turn will mean more biogas, more slurry and more nitrogen for the fields. Thus, there will be a

Cowdung in the pit is flushed into the digester (left). The mixture ferments, producing biogas in this family-size unit in a Haryana village (Earthscan/Mark Edwards)

positive feedback in the entire system with both biogas production and rice production rising in the village. If some chemical fertilisers were also used in the fields, it would add to the availability of fodder, dung, slurry and therefore nitrogen.

Injambakkam at the moment imports 90 tonnes of firewood and some kerosene every year. Each household spends two hours 20 minutes each day collecting wood. With the introduction of a community biogas plant using cowdung, available human excreta and water hyacinth, 10 hectares of casuarina plantations and energy efficient wood stoves, the village will be able to export substantial quantities of firewood.

All this will, of course, remain a dream unless the social and organisational issues involved in the promotion and adoption of biogas plants are fully understood and solved.

Social scientists have a major role to play. For instance, a major lacuna in the literature about rural energy systems is that the exact production, distribution, and use patterns of dung, fodder, and other energy resources have not been carefully traced. Little is known about the percentage of the total dung production used as cooking fuel in the country. While in Bhundri village in Punjab, cowdung is the most important energy source, it is rarely burnt in Pura, and Injambakkam. Estimates of the proportion of cowdung generated that is burnt vary from 40 per cent (used by the NCAER) to 75 per cent by some independent researchers. The Ministry of Food and Agriculture is reported to use an estimate of 66 per cent. Also little is known about the circulation of cowdung in the village economy: who takes how much cowdung, produced where, by a cow belonging to whom.

Without such knowledge it is difficult to anticipate the consequences of installing biogas plants.

Agricultural wastes

Like cowdung, it is difficult to estimate the quantity of agricultural wastes generated in the country every year and the proportion that is normally used as fuel. The total agricultural wastes in 1976-77 were estimated to be around 200 million tonnes of which about 40 million tonnes were probably used as fuel. Now that foodgrain production has reached 130 million tonnes, residues from grain crops alone should be up to 250 million tonnes.

As agricultural wastes are available at zero or low private cost to a farmer, it is unlikely that their use as energy sources will decline, especially when the price of commercial fuels like kerosene is increasing. Although in the long run it may be necessary to discourage the use of agricultural wastes, in the present situation efficient technologies for using them as a cooking fuel need to be developed. In the Philippines, for instance, efficient stoves have been developed which burn rice husks. Similar stoves, if introduced in India, could use paddy residues currently burnt in Punjab, for instance.

Agricultural wastes are too bulky for farmers to store in their houses. They are left on the fields where they decay during the monsoon. Cotton stalks left in this manner carry pests which affect the next year's cotton crop. If a simple technique existed for cutting these stalks and converting them into bricks, they could be easily transported and stored by villagers. A more detailed look is clearly necessary at the use of agricultural wastes in the villages and how it could be made more efficient.

Contrary to common belief, increased agricultural production in the green revolution areas has resulted in a greatly increased quantity of crop residues. A high yielding variety (HYV) allocates a larger proportion of its total biomass to grain rather than to leaves and stems. This has given rise to an erroneous belief that green revolution agriculture will reduce crop residues. But cultivation of HYVs with inputs of fertilisers and irrigation increases the total biomass produced over a unit area of land. A recent study shows that while old varieties of wheat produce an average 879 gm of biomass per sq m, new varieties of wheat produce 1345 gm per sq m with nitrogen inputs of 100 kg/ha.

Though old varieties with the same amount of fertilisation would have yielded a greater amount of biomass, it is unlikely that farmers will use them because they will yield less grains than the high yielding varieties. In the process, however, as far as the farmers are concerned, they get a larger quantity of crop residues.

Potential for biogas

Although calculations about the biogas potential in the country vary, it is clear that with some planning and push, the use of biogas as an alternative cooking fuel could be encouraged.

The secretary of the working group on energy policy, T.L. Shankar, argues that with the cattle population remaining steady and foodgrain production rising, the quantity of crop residues available per head of cattle will increase. If these fodder resources are properly used, the working capacity of cattle should improve and dung production increase by a guesstimate of 50 per cent. This amount of dung should be sufficient for 560,000 community plants of 140 cu m per day, each one meeting the needs of 500-600 people, and some 1800 million family plants of 1.68 cu m each. The total investment would be about Rs 6600 crores.

Dr Kirit Parikh, another member of the working group, estimates that if the current dung output doubles with an improvement in the health of the cattle, and 80 per cent of the dung generated can be collected, 200 million well-fed bovine animals will be sufficient to feed 1.6 million community plants 168 cu m per day gas output) — enough to meet 90 per cent of the domestic needs of the projected 660 million rural population in 2000.

The Bhundri example

A detailed study of the potential of agricultural wastes in a village in district Ludhiana has been conducted by Dr B.S. Pathak of the Punjab Agricultural University. Bhundri is a relatively rich village with several tractor-operated farms, where all farmers practice green revolution agriculture. Wheat, paddy, maize, cotton and groundnut are the major crops. Although the village is rich, as much as 98 per cent of the household energy is still spent on cooking. Over 70 per cent of all animal wastes are used as fuel. Even farmers who understand the importance of manure contribute the maximum share to household energy: 56 per cent on bullock-operated farms and 43 per cent on tractor-operated farms. The next major source of energy is crop residues: 22 per cent and 28 per cent respectively of the household energy. Firewood provides only 20.5 and 26.7 per cent respectively of the household energy.

Fossil fuels and electricity, even in this rich village, provide only 1.9 and 1.7 per cent of the total household energy used, respectively. The tractor-operated farms have much higher yields of crop residues which are used as fuel and fodder.

Pathak's calculations of the energy supply and demand situation in the village yield an amazing result. After all the fodder needs of the village have been met, the energy potential of the remaining crop wastes and animal wastes is enough to meet all the energy requirements of the village and still leave a surplus.

In a situation where supplies of conventional energy sources like firewood are decreasing and alternatives like kerosene are still not within the reach of many, this increase in energy supplies will benefit society and especially the poor. However, in the long run regular use of agricultural wastes as fuel could affect soil fertility, steadily depleting it of micronutrients and organic matter. (See chapter on Land). Use of agricultural wastes cannot, therefore, be regarded as a permanent solution by any society dependent on intensive farming.

Another question is: will increased availability of energy in the village really mean more energy for the poor? There is no definite evidence to believe that would be so. On the contrary, even in Pathak's fuel rich Bhundri village, there are three families who have to resort to collection of dried wild plants for meeting some of their household energy needs.

Solar cookers

The most exotic system for cooking food is that of solar cookers. India was amongst the first countries in the world to take an interest in this. In the 1950s, the National Physical Laboratory started work in this field but unfortunately became a laughing stock when Pandit Jawaharlal Nehru had to wait long to get a cup of tea. With the world pushing incessantly towards oil, India too decided to follow the mainstream and gave up interest in developing solar cookers.

Interest has once again awakened in this field. Several types of solar cookers have been developed by governmental and voluntary agencies across the country. The Gujarat Energy Development Agency has already sold 7000 simple box-type solar cookers at a cost of about Rs 500 each, the Jaydip solar cooker, a parabolic concentrator costing about Rs 1000 has been bought by several people in Pune, and well-known Bombay architect Shirish Patel has developed another design which he has demonstrated to women in a small town of Maharashtra.

The Department of Science and Technology has formulated plans to promote 25,000 solar cookers over the next year. Nodal agencies have been identified in each State which will grant licenses to entrepreneurs, ensure the quality of their products and provide a subsidy of Rs 150 per cooker for the first 10,000 solar cookers. To the consumer, each cooker will cost Rs 345.

Meanwhile, the Jyoti research and development centre, a private agency in Gujarat, has been exploring another novel approach to solar cooking: the use of hot water from solar water heaters for cooking purposes. A flat plate solar collector can easily supply hot water at temperatures upto 90°-95°C. At these temperatures, rice, potatoes and vegetables can be cooked, in 30 to 45 minutes, without much difficulty. Simply using hot water from the solar system for cooking instead of cold water has led to substantial savings of fuel in the Jyoti canteen.

Not cheap enough

While all this may be technologically exciting, there remain several questions about the acceptability of these systems and their effect on environmental preservation. At their current price of Rs 345, even after the government subsidy, the DST solar cookers are not going to be within the reach of rural poor. As Mohan Parikh, the first promoter of the box-type solar cooker, points out: "The rural poor are unlikely to use it even if it is given free to them". The detailed study of cooking hours in Pura shows that most of the cooking in the village is done when the sun is not shining strongly: 6 to 10 am in the morning and 6 to 9 pm in the evening. Hence, for solar cookers to be useful, either these families must change their living patterns, or solar energy must be stored for cooking at night. Storage systems for solar power will raise the costs of solar cookers even further. No technical breakthroughs for cheap energy storage systems appear to be imminent though several efforts are being made.

A solar cooker should, however, be useful for the urban middle class households — even a family which uses LPG as cooking fuel should benefit. Assuming that the family uses one LPG cylinder a month at Rs 50 per cylinder, it should be able to recover the cost of a Rs 500 solar cooker within three to four years, even if it cooks only half the dishes for the afternoon meal. As a larger number of urban households burn firewood and their demand is a major factor in the deforestation of the country, these solar cookers would be valuable from an environmental point of view. But special efforts may be needed to ensure that such cookers reach urban families using firewood, who may be residing largely in non-metropolitan towns, or are amongst the poorer households of the metropolitan cities.

Therefore, if the purpose of solar cookers is to replace firewood and not just kerosene, a clear identification of the target groups in urban areas is needed both in geographical and economic terms. To reach the poor in the metropolitan towns, the subsidies on solar cookers may in fact have to be increased. No studies are yet available which show what fuel the families who have bought solar cookers were using and whether they continue to use their solar cookers after the

novelty effect has worn out.

Yet another problem is the current housing style of multi-storey flats which militates against the use of solar cookers. Poor and middle class urban households, generally live in small, congested surroundings, with no backyard or even access to the roof. These families may find that even if they want to use a solar cooker, they are physically unable to do so.

The need, therefore, to push towards solar energy is obvious but promotional problems will be plenty.

COMMERCIAL COOKING FUELS

While the importance of coal for cooking energy in India has been steadily decreasing, the importance of oil products like kerosene and LPG has been increasing. The household sector accounts for about 20 per cent of the total oil used in India. Kerosene is particularly important as a source of cooking energy in Indian metropolitan cities. Total kerosene consumption now stands at about four million tonnes every year, of which about 40 per cent is imported.

Kerosene

Kerosene consumption has been growing and this year the government had to resort to a crash purchase of 0.15 million tonnes of it. After the oil price rise of 1973-74, kerosene consumption had dipped for the first time. But since 1975, the demand for kerosene has picked up sharply again, especially in cities like Bombay and Calcutta.

The per capita kerosene consumption of the rural and urban poor seems to be almost equal, while that of the rich in the urban areas is high when compared to the same expenditure class in rural areas. This is probably because the poor use non-commercial energy sources for cooking and kerosene for illumination while the richer sections tend to use electricity for illumination and kerosene for cooking. The still richer sections tend to replace kerosene for cooking with LPG. Data relating to kerosene use for lighting and cooking is not available separately.

Consumption of kerosene is expected to grow further unless specific measures are taken to alter current trends. The working group on energy policy pointed out that compared to less than one per cent of rural households and 17 per cent of urban households in 1975-76 which were totally dependent on kerosene for their cooking needs, 22 per cent of rural households and 50 per cent of urban households will become dependent on it by the end of the century. An additional three per cent and 25 per cent rural and urban households will become dependent on LPG for cooking by 2000. As much as 13 million tonnes of kerosene and 3.3 million tonnes of LPG would be required by then, assuming current standards of consumption.

Coal

The consumption of oil products for cooking will decrease only if specific measures are taken, especially in the urban

A Punjabi woman and her daughter preparing chapattis on a kerosene stove. Among commercial sources of energy, kerosene is a close second to coal. (WHO)

areas. The first obvious solution is to replace the consumption of oil products with indigenous coal. Several government agencies have considered this idea but little has really come out of it, and now an India flush with oil discoveries cares even less.

In 1964, the Central Fuel Research Institute had conducted a study of the domestic fuel needs in urban areas: the total requirements were assessed at 7.5 million tonnes of coal equivalent. The report suggested that the country be divided into nine zones for soft coke production and indicated likely sites for locating low temperature coke units.

The substitution of urban kerosene consumption by coal was later reviewed by a Planning Commission working group on coal gasification in 1974. This group also recommended the installation of small to medium size coal gasification plants at a couple of selected consumption centres.

The working group on energy policy in 1979 pointed out that even with kerosene and LPG consumption rising, past trends show that the consumption of coal will rise from about five million tonnes in 1982-83 to 24 million tonnes in 2000, which means an annual increase of 0.5-1 million tonnes of coke production during the 1980s and two million tonnes during the 1990s.

However, no efforts have been made to achieve these targets. Moreover, well over 90 per cent of the current estimated production of about five million tonnes of soft coke is achieved only by the inefficient and highly polluting process of open air "carbonisation" of coal heaps. No serious effort has been made to introduce less polluting, new technologies.

If a concerted effort is made to meet urban cooking needs, Professor Amulya Reddy has argued that it should be possible to replace kerosene consumption completely. Gaseous cooking fuels can be provided to all urban households through piped mixtures of sewage, coal and producer gases. Though this may not be an easy task, clearly if India wants to stop further reductions in its green cover, the massive cooking energy needs of urban households will somehow have to be met, especially to replace the substantial use of firewood in urban India.

LPG

The Government is planning a major increase in LPG supply with a number of oil refining units expected to come on stream soon. The annual production of LPG is expected to go up sharply from five lakh tonnes at the moment to about 18 lakh tonnes by 1986-87. About 1.4 million new connections are expected this year and 1.6 million new ones every year thereafter. By 1982-83, LPG supplies should be reaching all towns with a population of over 50,000. This would cover all district headquarters in the country. Within a few years thereafter, every town having a population of more than 20,000 will also be covered.

There are about 350,000 registered LPG customers at the moment and another four million are said to be on waiting lists. Within a few years the Government should be able to clear off this entire list. As few can spare Rs 1000 to buy gas cylinders and stoves, the list may not expand as rapidly as supply. The import of LPG has been going up steadily from 17,040 tonnes in 1979-80 to 44,844 tonnes in 1981. But with new units coming up, LPG imports may stop altogether.

A NATIONAL COOKING ENERGY POLICY

If the Government wants to help meet the basic needs of our population without causing wholesale environmental destruction, an integrated national cooking energy policy is an imperative. If the Government fails to come up with an implementable policy, or lacks the will to implement one, the results will be disastrous both for the people as well as the environment.

To date, in terms of rural planning, cooking energy requirements have been virtually ignored. Meanwhile rural electrification programmes, which do not benefit even those who are reached by them, are being pushed. The most inhuman drudgery which is, in fact, increasing in current society is that of the long hours that millions of women have to spend on collecting basic needs like fuel and water.

Past attempts to increase supplies of cooking energy have been marked by ad hoc technology-based attempts to push biogas plants or some other technology like solar cookers and now fuelwood plantations. A far more systematic approach is needed so that each technology is pushed towards an appropriate target group — both in geographic and economic terms.

Moreover, an overall national policy is needed which covers the demands of both the urban and the rural areas. There are growing interactive linkages between the two; demand in one can destroy the environment in the other. Pushing LPG in the metropolitan towns while leaving the small towns to fend for their own cooking fuels can easily spell environmental disaster in the villages.

Where renewables cannot find a place, non-renewable sources like coal should be available. The supply of cooking energy should not remain a few virtuous paragraphs in our energy plans.

WILDLIFE

With only two per cent of the world's land mass, India possesses around five per cent of the known living organisms on earth.

Today a significant portion of the 15,000 plant species and 75,000 animal species found in India are threatened by the pressure of human activity on land and forests.

A little over 10 per cent of India's flora faces extinction; many species may be lost even before their possible value is known to society.

Of the 134 most threatened plant species, 99 are in the Himalayas and the Northeast.

Wildlife is threatened by a flourishing illegal trade in wildlife products. Before the ban on the trade of raw snakeskins in 1976, Indian dealers sold 3.5 million reptile skins overseas.

Japan imported 150 kg of musk from India at Rs 40,000 a kg in 1980. A musk deer's glands secrete at most 40 gm of musk.

Elephants, once found all over India, have now disappeared from Maharashtra, Madhya Pradesh and Andhra Pradesh.

Over 600 different orchid species, almost three per cent of the world total, are found in Northeast India. Many of these species may soon disappear without a trace.

10

WILDLIFE

The Indian subcontinent is one of the most fascinating ecological and geographic regions in the world. Here lies the nearly rainless desert of Thar and the rainiest place on earth — Cherrapunjee; the hot, salty Rann of Kutch and the permanently snow-bound peaks of the Himalayas; the wet coastal regions of Kerala and the Islands of Andamans and Nicobar; the great lake of Chilka and the river system of Ganga-Brahmaputra.

This variety of ecological conditions sustains a tremendous amount of diverse life forms. About 15,000 species of plants (out of a known world total of 250,000) and 75,000 animal species (out of a world total of 1.5 million) have been described from India. On two per cent of the world's landmass, we possess around five per cent of the known living organisms on earth.

India lies at the confluence of the African, European and Southeast Asian biological systems; it possesses interesting components from each of these realms, as well as several peculiarly indigenous flora and fauna. Among other examples, the African element is represented by the Hyena and the Gazelle (Chinkara), the European by the Wolf, Wild Goat (Markhor) and Kashmir Stag (Hangul), and the Southeast Asian by the Hoolock Gibbon and the Elephant. The fauna peculiar to India include the Sloth Bear, Blackbuck, four-horned Antelope and snakes belonging to the family *Uropeltidae*.

With over 1200 species and about 900 subspecies of birds, India's avian diversity is unmatched except by Latin America. Well-known Indian birds include the colourful national bird, the Peacock, the stately Sanus Crane which stands five feet tall, and the world's second heaviest land bird, the Great Indian Bustard. Five hundred thousand flamingoes nest in the Rann of Kutch. Bharatpur, world famous as a sanctuary, houses over a quarter million birds. These birds play a vital role in the ecosystems they inhabit. Trees like sandalwood and semul, both economically important, depend on birds for their pollination. A single owl can eat up to 800 rats a day and in the same amount of time, fledglings eat more than their weight in insects.

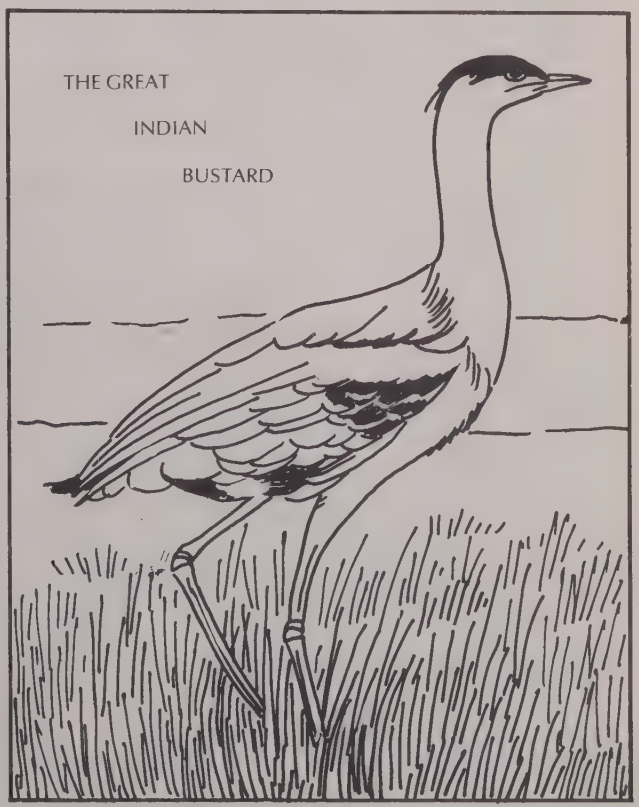
Today, a significant portion of this cornucopia is threatened by the pressure of human activity on land and forests. What makes matters worse is that knowledge of our wildlife is still largely incomplete, except for a few groups of organisms such as birds. "It is a moot point whether we will have the chance to describe all the species of fungi, mosses, insects and mites, that are as yet unknown, before they disappear silently," says Dr Madhav Gadgil, a National Environment Fellow. The Cheetah, the Pink-Headed Duck and the Jerdon's Courser have already disappeared from India. Schedule One of the Wildlife (Protection) Act, 1972 lists 133 species as either rare or highly endangered.

A little over 10 per cent of India's flora also face extinction. "Extinction is more tragic with plants than with other forms of life", says the International Union for Conservation of Nature and Natural Resources (IUCN). "Many species will be lost before their possible value to society is known", it adds.

Ecologists have only recently begun to study in detail India's various ecosystems in an attempt to preserve their wildlife ensembles.

IMPACT OF PEOPLE ON WILDLIFE AND ECOLOGY

Human beings have coexisted with plants and animals on the Indian subcontinent for at least 50,000 years. Ninety per cent of this time has been spent by them as hunters and gatherers. Many tribes continue to do so even today, such as the Cholanaiks, a primitive, cave-dwelling tribe of the Nilambur forests in Kerala, and the Jorwas of the Andamans. The hunter-gatherers must have slowly but significantly



Of elephants and people

Once many kinds of elephants roamed the earth; they were amongst the largest mammals ever known. Of these only two types have survived, the African and the Asian (often called the Indian) elephant.

Wild elephants live in river valleys which are also the best areas for cultivation. This has inevitably led to furious struggles between elephants and humans for mastery over the land. Kautilya's Arthashastra prescribes as a duty of the king, the extermination of elephants from cultivated river valleys. That elephants once roamed all over India is clear from seals of the Indus valley civilization.

Domesticated over 2500 years ago, the elephant became a valuable beast of burden, capable of dragging loads of upto two tons. It was also a great asset in war and a symbol of prestige. Kautilya therefore prescribes the preservation of great elephant forests, particularly near the borders of the country. Elephants were strictly protected in these forests, their populations continually monitored by a special officer, and poachers were punished with death.

By the Mughal era, elephants had already retreated from Punjab and Rajasthan but were still quite abundant over most of Madhya Pradesh. They continued to play a role in warfare till the eighteenth century. The British tremendously enhanced the pace of forest exploitation, and elephants began to play a major role in timber operations. The Bombay-Burma Trading Company once owned over 4000 working elephants. Today, with attrition of forests and the advent of trucks, they play a minor role in timber logging.

The conflict between humans and elephants, however, continues to gather momentum. Once found in all parts of India, except those with low rainfall, they are now restricted to the hill forests of Kerala, Tamil Nadu and Karnataka, the Northeast, the Himalayan foothills in UP and in West Bengal, Orissa and south Bihar. They have disappeared from Maharashtra, Madhya Pradesh and Andhra Pradesh which still possess suitable forest habitats. M. Krishnan, the eminent naturalist, estimates the present population of wild elephants to be about 10,000 and says, "Even if it is that, the population is definitely much less than in the past".

In the Eastern Ghats on the Tamil Nadu-Karnataka border the forest has become a patchwork of millet fields in the valleys and scrub jungle covering the hills. Faced with a fragmenting habitat, elephants are in serious conflict with the farmers and raiding of crops is a perennial problem throughout the tract. Some 20 people are killed annually by elephants in attacks, provoked and unprovoked, and an equal number of elephants are shot at and killed by people. The eventual outcome will be a slow elimination of elephants over this tract, an affair accompanied by much agony.

Elephants cannot be protected on a long term basis in such fragmented habitats. They need adequate areas of contiguous forests. Often such contiguity is lost by thoughtless destruction of vital corridors. Thus, the forests on slopes and at the base of the Nilgiris provide a viable habitat for elephants. One of the elephant corridors in this habitat linking the Mudumalai forests with the Nilambur slopes was recently destroyed by the Government Tea Corporation. The tea plantation could easily have been located in a less sensitive area.

When undisturbed, elephants roam extensively and despite voracious appetites — they can eat upto 200 kg of fodder per day–they rarely destroy vegetal tracts. When disturbed by human activities, elephants panic and react with hostility. In a recent incident, near the Palamau forest in south Bihar, two wild elephants were knocked down by a goods train. A herd of seven or eight trumpeting elephants responded to the calls of their injured friends and blocked the train for the night in retaliation.

Careful protection from poachers is also needed to ensure their survival. Though elephants were among the first species to be afforded protection by law, the ivory trade has taken a heavy toll of their population. In the Periyar forest reserve in Kerala, once India's finest elephant habitat, tuskers that were easily seen in the fifties are now rare.

The key to the long term survival of wild elephants is the allocation of just a handful of protected reserves where substantial areas of contiguous habitat are still available. The proposed 6000 sq km biosphere reserve in the Nilgiris, which would harbour about half of South India's wild elephants, is a step in this direction.

SHARAD GAUR

affected the plant and animal life around them through hunting and the use of fire. Fossils found in the Narmada river bed reveal evidence of the hippopotamus and the baboon, species which vanished from India some 10,000 years ago, probably under hunting pressure. The middle Stone Age cave paintings of Bhimbetka and other areas of Madhya Pradesh show a species of wild cattle now extinct in India.

While the hunting-gathering tribes influenced life around them only mildly, the impact of human activity increased dramatically when people began to cultivate plants and maintain herds of domestic animals, beginning with the river valleys of northwestern India some 5000 to 8000 years ago. The cultivators' conflict extended beyond wild animals that attacked people, livestock, and crops to wild plants that competed with cultivated crops. As agriculturalists and pastoralists, our ancestors profoundly modified the habitat around them.

Agricultural civilisation spread gradually over much of India, but still largely left out the hilly and the dry tracts which retained forest cover and tribal populations with a hunting-gathering way of life. With such natural habitats scattered widely over the land, a fairly representative sample of India's plant and animal life remained intact until the British times. The consolidation of the British Raj, however, began a process of decimation of these habitats.

The animals had to go because vastly superior firearms were now available with human beings. Lion and tiger became big trophies. At the beginning of the British Raj, lions roamed over a vast tract of northwestern and northern India. A denizen of the open scrub, the lion was extremely susceptible to hunting pressure, and by the close of the nineteenth century, it was confined to a single hunting preserve, Gir, belonging to the Nawab of Junagarh. The Nawab protected the remaining handful of lions from the hunting greed of British dignitaries by pretending that they had been wiped out. From a mere 20 or so, their population grew to about 200, the level at which it has remained for several decades.

More insidious than hunting, however, was the destruction of forests wrought by the British because of the great demand for railway sleepers, wood charcoal, ships and so on. To get this wood, the British took over, without compensation, vast tracts of communally-owned forests throughout the country — an act of robbery surpassed only by the usurping of entire continents like North America and Australia by white settlers.

Endangered Wildlife

The first comprehensive listing of endangered wildlife species in India was compiled in the Wildlife (Protection) Act, 1972 which provides for protection of threatened faunal species from indiscriminate hunting. Schedule One of the Act indentifies 70 mammals, 22 reptiles and amphibians and 41 birds as rare and highly endangered species, which are totally protected throughout the land.

The lion-tailed Macaque which inhabits the evergreen rain forests and "sholas" of south India, is among the world's most endangered primates. Referring to it, Dr Paul Heltne, who specialises in primates' reproduction research at the Johns Hopkins School of Medicine in Baltimore, says, "There may be no more than 195 of this beautiful animal left in the wild .....Its forest home has diminished rapidly over the last 30 years to a small fraction of its former extent."

The Lion-tailed Macaque is threatened with extinction due to the rapid disappearance of its natural habitat, the evergreen forests and "sholas" of South India. (Sharad Gaur)

The Wolf, the Jackal, the Indian Fox and the Wild Dog are among the threatened carnivorae. One estimate places the population of the Indian Wolf at a mere 500 to 800. With their habitats and prey diminishing rapidly, wolves are preying increasingly on livestock, and are therefore being killed by shepherds and farmers.

Among the feline animals the big cats like the Tiger, the Lion, the Leopard and and the Snow-Leopard are hunted for commercial purposes and protection of livestock. The small felines like the Lynx and the Marbled Cat are killed for their pelts. The one-horned Indian Rhinoceros was hunted for its horn, believed to have aphrodisiac properties, almost to the point of extinction by 1904. Rhino horns were sold at over Rs 61,000 a kg at an auction in Gauhati last year.

Five out of the nine species of deer in India are either rare or endangered. These are the Manipur brow-antlered Deer (Sangai), the Kashmir Stag (Hangul), the Swamp Deer (Barasingha), the Alpine and the Forest Musk Deer. The Sangai, once thought to be extinct, is one of the world's most endangered species with a mere 30 surviving in their natural habitat and an equal number in captivity. This deer was protected by royal edict and the threat of corporal punishment, till the British rule came to this region in the last century.

Zafar Futehally, India's eminent naturalist, notes that the Hangul population was down to 150 in 1970, mainly due to

poaching by army officers, and is now upto 320. Musk Deer have been hunted for centuries for their musk which is used in perfumes. A report in the newsletter of the World Wildlife Fund-India, says," At the turn of this century, musk sold for about Rs 10 per tola (11.6 gm), then equivalent to half its weight in gold. Today musk is worth up to Rs 4200 a tola, or four times its weight in gold." Despite a ban on the musk trade in 1972, its illegal trade flourishes in India.

Eleven species of flying squirrels and two marmots belonging to the order Rodentia are also on the endangered list. They are killed for their pelts and flesh.

Indian reptiles which include lizards, snakes, crocodilians, tortoises and turtles are exploited for their eggs, flesh, skin and even venom. Granite blocks and embankments built as a protection against erosion of beachfronts have "fenced-off" 200 km of the Kerala coast from nesting sea turtles. This has led to the disappearance of four out of the five species of turtles found on the Kerala coast. On the east coast the Olive Ridley sea turtles are being slaughtered for their flesh and eggs. Earlier this year, 500 Olive Ridleys were killed in two days at Digha beach in West Bengal, to be sold in the Calcutta market, in open violation of the Wildlife (Protection) Act, which lists these turtles under Schedule One.

Habitat destruction, pollution of air and water, and the increasing drainage of wetlands have taken a heavy toll of bird life in India. Hunting for sport and trapping for the cage bird trade have contributed to their decline. Deforestation threatens among others most species of hornbills, the bamboo partridge and Himalayan forests birds including colourful pheasants and tragopan species. The Indian Skimmer, a resident of the major Indian rivers, is becoming

RARE AND ENDANGERED SPECIES

The following is the list of highly endangered or rare mammals, reptiles and amphibians and birds according to Schedule One of the Wildlife (Protection) Act, 1972, as updated in 1979.

Mammals

1. Andaman Wild Pig
2. Bharal
3. Binturang
4. Black Buck
5. Blue Whale
6. Brow-antlered Deer
7. Capped Langur
8. Caracal
9. Cetecean species
10. Cheetah
11. Chinese Pangolin
12. Chinkara or Indian Gazelle
13. Clouded Leopard
14. Crab-eating Macaque
15. Desert Cat
16. Dugong
17. Fishing Cat
18. Four-Horned antelope
19. Dolphin (Gangetic)
20. Flying Squirrels
21. Golden Cat
22. Golden Langur
23. Himalayan Ibex
24. Himalayan Tahr
25. Hispid Hare
26. Hog Badger
27. Hoolock Gibbon
28. Hump-backed Whale
29. Indian Elephant
30. Indian Lion
31. Indian Wild Ass
32. Indian Wolf
33. Kashmir Stag
34. Leaf Monkey
35. Leopard or Panther
36. Leopard Cat
37. Lesser or Red Panda
38. Lion-tailed Macaque
39. Loris
40. Lynx
41. Malabar Civet
42. Malay or Sun Bear
43. Marbled Cat
44. Markhor
45. Mouse Deer
46. Musk Deer
47. Nilgiri Tahr
48. Ovis Ammon or Nyan
49. Pallas's Cat
50. Pangolin
51. Pygmy Hog
52. Ratel
53. Rhinoceros
54. Rusty-Spotted Cat
55. Serow
56. Sloth Bear
57. Slow Loris
58. Small Travancore Flying Squirrel
59. Snow Leopard
60. Spotted Linsang
61. Swamp Deer
62. Takin or Mishmi Takin
63. Tibetan Antelope or Chiru
64. Tibetan Gazelle
65. Tibetan Wild Ass
66. Tiger
67. Urial or Shapu
68. Wild Buffalo
69. Wild Yak

Amphibians and reptiles

1. Agra Monitor Lizard
2. Atlantic Ridley Turtle
3. Barred, Oval or Yellow Monitor Lizard
4. Crocodiles
5. Gharial
6. Ganges soft-shelled Turtle
7. Green Sea Turtle
8. Hawksbill Turtle
9. Himalayan Newt or Salamander
10. Indian egg-eating Snake
11. Indian soft-shelled Turtle
12. Indian Tent Turtle
13. Large Bengal Monitor Lizard
14. Leathery Turtle
15. Logger-head Turtle
16. Olive-back logger-head Turtle
17. Peacock-marked soft-shelled Turtle
18. Pythons
19. Three-keeled Turtle
20. Tortoise
21. Viviparous Toad
22. Water Lizard

Birds

1. Andaman Teal
2. Assam bamboo Partridge
3. Bazas
4. Bengal Florican
5. Black-necked Crane
6. Blood Pheasants
7. Brown headed Gull
8. Cheer Pheasant
9. Eastern White Stork
10. Forest spotted Owlet
11. Great Indian Bustard
12. Great Indian Hornbill
13. Hawks
14. Hooded Crane
15. Hornbills
16. Houbara Bustard
17. Humes bar-backed Pheasant
18. Indian Pied Hornbill
19. Jerdon's Courser
20. Lammergeier
21. Large Falcons
22. Large Whistling Teal
23. Monal Pheasants
24. Mountain Quail
25. Narcondom Hornbill
26. Nicobar Megapode
27. Nicobar Pigeon
28. Osprey or Fish eating Eagle
29. Peacock Pheasant
30. Peafowl
31. Pinkheaded Duck
32. Scalater's Monal
33. Siberian White Crane
34. Spur Fowl
35. Tibetan Snow-cock
36. Tragopan Pheasants
37. White-bellied Sea Eagle
38. White-eared Pheasant
39. White spoonbill
40. White-winged Wood Duck

exceedingly rare due to water pollution. The Siberian Cranes, regular winter migrants to the wetlands of northern India, have declined from 77 in 1972 to 33 in 1980. The Great Indian Bustard has been exterminated over most of its range due to hunting and habitat destruction.

The Botanical Survey of India, in a recently published "State of the Art" report lists 134 most threatened plant species, of which 99 are in the Himalayas and the northeast. Twenty eight species of orchids are endangered, some of them being smuggled by hashish dealers and sold at fabulous prices abroad. Among the most threatened floral species are the endemic life forms which are limited to narrowly localised areas or ecological niches. Dr Madhav Gadgil and Dr V.M. Meher-Homji, both well-known ecologists, observe, "A grass species known only from the spray zone of the Jog Falls has apparently disappeared after a dam reduced the river flow. Many other species have undoubtedly vanished from the now thickly populated west coast plains without their ever having been described."

Finally a vast majority of India's aquatic habitats and marine ecosystems which include hill streams, the major river systems, lakes, backwaters, wetlands and coral islands, are polluted or otherwise degraded. We have lost over 16,000 sq km of mangroves in this century alone due to ill-planned urbanisation and chemical pollution. The famous Dal Lake in Srinagar is shrinking due to human encroachments. The Pulicat lake, a great centre for breeding of water birds in Andhra Pradesh, is threatened with chemical pollution. According to the Sixth Five Year Plan (1980-85) document, "Coral reefs rich in limestone, have been thoughtlessly plundered for the manufacture of cement in the Gulf of Manaar (Tamil Nadu) and the Pirotan Islands (Gujarat), and threatened in Lakshadweep, and in the Andaman Islands."

Endangered flora and fauna in Northeast India

Northeast India has the third largest resource of plants in the world for any area of similar size. About 50 per cent of the total flora of India comes from this region.

The genetic diversity found in cultivated crop plants like citrus, banana, coffee, tea, maize, paddy, capsicum, potato, oilseeds makes Meghalaya a natural germ plasm bank which can be used for evolving further strains.

One of the world's most comprehensive collections of primitive rice cultivars have been found here. The region is a natural orchid germplasm bank with as many as 600 different species, almost three per cent of the world aggregate of orchid species. The effect of deforestation on the other wildlife of Meghalaya is devastating. There is little documentation of what does exist, so a policy of conservation has yet to be evolved.

Vast treasures of medicinal plants like Sarpagandha, *Rouwolffia Serpentina*, the source of a valuable drug, Reserpine, are being depleted. So too is tribal knowledge related to their use. The World Health Organisation (WHO) has started documenting and testing popular tribal remedies around the world. Primitive knowledge about medicinal plants is so vast that information of 3000 plant species that have been used for population control have been computerised by WHO.

A third of the species of insectivorous plants known in India are indigenous to Meghalaya. Their growth has been destroyed by jhumming and development activities. Edible fungi and rich lichen habitats are also prone to destruction in clearing operations. Orchids, which are shade-loving plants, flourish in the dusky floors of dense forests and die quickly once the shade-giving trees are removed.

The tropical forests in the Garo Hills and parts of the Khasi and Jaintia hills, once abounded in wild elephants, deer, wild boar, gaur, wild buffalo, Capped Langur and the Hoolock Gibbon among other animals. No data exist of the population of these animals except for tigers. In 1972, there were just 32 tigers in the state. In 1979, their number went up to 35. The Barking Deer is now a rare sight. This deer was one of the main dispersing agent of the seeds of certain plant species through its excreta. Wild elephants are most threatened in the Jaintia Hills where their habitat has succumbed almost totally to jhumming. They damage crops and are in constant conflict with the farmers.

The Peafowl, Hornbill, Tragopan Khaleej Pheasant, and Whistling Teal once abundant in Meghalaya are now rare. Wild birds which consume pests like locusts and wood-destroying termites are not finding enough tree cover and are instead invading crops and kitchen gardens. Consequently crop pests have also increased leading to an increase in the use of pesticides. Besides increasing production costs, these are polluting the hill streams.

As part of the Biosphere Reserves programme in the Sixth Plan, the Government of India proposes to establish a gene sanctuary, where considerable genetic variety occurs in economically important plants, for *Citrus indica*, in Meghalaya. "Wild types of citrus are relatively more common in the Northeast and the Himalayan foothills. All except *Citrus indica* are prevalent and hence do not need particular attention for their protection. *Citrus indica* being the most primitive and perhaps the progenitor, deserves special consideration," says Dr Bhag Singh, a scientist at the National Bureau of Plant Genetic Resources in Shillong. The Government of Meghalaya has established a sanctuary for the endemic "pitcher plant" in the Khasi Hills. Some varieties of Himalayan orchids and *Dioscorea*, a climbing plant, have also been collected and preserved.

CONSERVATION

Traditional approaches

While India's biological heritage has thus been slowly eroded over the millenia, the society has been evolving a number of practices to preserve this diversity. In the hunting-gathering stage itself, protection was extended to totemic animals. Early Indian literature, including the Hindu epics, the Buddhist Jatakas and the Panchatantra and the Jain strictures against violence to even lowly life forms, are eloquent proof of the respect accorded to wildlife in ancient Indian culture. An eternal symbol of this tradition is Ganesha, half man, half elephant, the son of Shiva and Parvati, and a God in his own right.

Even today, there are some communities that are totally dedicated to conserving wildlife. The most famous example is that of the Bishnois of northern India, a 390-year-old sect which observes some 29 principles for conservation of plants and animals, especially certain threatened species. In Rajasthan and Haryana, many Blackbucks and Khejdali trees, which are otherwise rare, can be seen around Bishnoi villages. With modernisation creeping in and subsistence occupations which once supported such communities rapidly losing out, these cultural practices are slowly disappearing. "This is the sad tale of popular conservation efforts in India today", says Madhav Gadgil.

The Mores of Maharashtra still believe in protecting the peafowl and rats find sanctuary in the temple of Karanimata near Bikaner. Birds in Ranganthitoo pelicanary in Andhra Pradesh and the mixed heronies of Kokkarebellur and Banhalli in Karnataka have been protected by local communities since times immemorial. The Banyan and Peepul trees dotting much of our countryside and the large populations of Rhesus monkeys, so useful in modern biomedical research, are a legacy of these traditions.

Even more striking for a conservationist are the practices of protecting entire biological communities such as sacred groves and lakes. Near the temple of Rudranath in the Himalayas, several scores of hectares are dedicated to the guardians of the God. In these alpine pastures and Rhododendron forests, no lopping, grazing or even tramping with shoes is permitted. In Kerala, coastal evergreen forests now survive only in small pockets dedicated as sacred groves to serpent deities.

Traditionally, aristocracy would set aside hunting preserves. The practice finds a mention in Kautilya's Arthashastra. Even earlier, in the third century BC, Ashoka forbade the slaughter of certain birds in his fifth pillar edict. The Mughal rulers were avid hunters, but kept up the preservation tradition. English tea planters who lived like princes in the hills also set up their own hunting preserves, for instance, Eravikulam plateau in the High Ranges of Kerala. Besides the Gir hunting preserve of the Nawab of Junagarh, many of our modern wildlife sanctuaries are such old hunting reservations. The tiger reserves of Simlipal, Bandipur and Ranthambhor, the bird sanctuary of Bharatpur and Eravikulam National Park are a few examples.

Modern approach

The modern nature conservation movement had its origins in the interests of sportspersons and naturalists. As the populations of the game animals began to decline steeply, particularly during and following World War II, a number of organisations of such sportspeople became concerned with the long-term conservation of wildlife. This effort was spearheaded by the Bombay Natural History Society, a premier organisation of sportspersons and naturalists of the country. Their efforts culminated in the establishment of the Indian Board of Wildlife and a network of wildlife sanctuaries and National Parks.

The end of World War II also witnessed the beginning of concern for wildlife conservation on a world-wide basis and the founding of the World Wildlife Fund, largely by European aristocrats. A branch of the World Wildlife Fund was also established in India and soon became the premier conservation society.

In the last decade, comprehensive legislation was enacted and action programmes were initiated to preserve wildlife in India. Based on the recommendations of the Indian Board for Wildlife, the main advisory body for wildlife conservation to the Government of India, the Wildlife (Protection) Act was passed by Parliament in 1972. As mentioned earlier, a special feature of this Act is a set of provisions to control hunting of endangered fauna. Now there are 19 National Parks (6471 sq km) and 205 National Sanctuaries (69,292 sq km) covering 2.3 per cent of the country's geographic area. The Sixth Plan has allocated almost Rs 40 million for their maintenance and development, up from Rs 18.4 million in the Fifth Plan.

Fierce looks are not enough to keep poachers away. Operation Crocodile has been remarkably successful in saving the three Indian species from becoming extinct. (Vipul Sangoi)

India's tiger reserves

Reserve	State	Area (in sq km)	Population
Manas	Assam	2840	69
Palamau	Bihar	930	37
Simlipal	Orissa	2750	65
Kanha	Madhya Pradesh	1945	71
Corbett	Uttar Pradesh	520	84
Bandipur	Karnataka	690	39
Melghat	Maharashtra	1571	63
Ranthambhor	Rajasthan	352	25
Sunderbans	West Bengal	2585	205
Periyar	Kerala	777	34
Sariska	Rajasthan	800	19
		15,760	711

Source: World Wildlife Fund-India (Newsletter No 34); Ministry of Agriculture, Government of India(1981)

Project Tiger

Project Tiger was initiated in 1973, in response to the alarming decrease in the population of wild tigers from 40,000 at the turn of the century down to 1827 in 1972. The project was launched by the Government of India with a grant of Rs 50 million in cooperation with WWF-India and IUCN who together pledged one million dollars for equipment and experts. In 1973, nine tiger reserves in nine states with a total area of 13,017 sq km were set aside, with a tiger population of 268. Today there are 11 reserves spread over 15,760 sq km in 10 states. Out of this, an area of 4963 sq km is set apart, as a core zone free from all human interference. All cattle grazing has been stopped in the core zone and several villages moved out. According to the 1979 tiger census, the nationwide tally of tigers was up to 3015 with 711 of them living in tiger reserves (see table).

There are three crocodilian species in India: the salt-water or estuarine crocodile, the fresh water, swamp crocodile or Mugger and the Gharial, a riverine species of the north Indian rivers. A status survey in 1975 showed that while all three species were endangered, the Gharial which had been abundant until a century ago, now numbered around 100. The rate of loss meant certain extinction in a short time. Operation Crocodile was launched by the Government of India in cooperation with the UN Food and Agriculture Organisation (FAO) in 1975. The prime focus was on the Gharial. Two thousand seven hundred Gharials have been reared at rehabilitation centres in special sanctuaries and 324 have been released into the Mahanadi, Chambal and Ghagra rivers.

To control the illegal trade in endangered species and skins India signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1976. Despite a few big seizures in the last couple of years, international smuggling rings continue to flourish. Poor people in the countryside are induced to kill animals whose skins are purchased at a nominal price by dealers. Compulsory checking of such cargo has little deterrent effect. One reason may be that the fat profits far outweigh the fines that are imposed under the current regulations. A sample list of prices in the Japanese market, the biggest market, published in "Business India" (November 9-22, 1981) shows how lucrative the trade is:

The strategy of setting aside reserved forest areas, adopted under Project Tiger, has provided a natural habitat and protection to this handsome cat. (Sharad Gaur)

Item	Price in US $
Clouded leopard skin	124,270
Bengal tiger skin	94,750
Tortoise shell (for glasses)	4,140
Lizard skin (for shoes)	1,750

The number of persons prosecuted for violating the Wildlife (Protection) Act has also fallen dramatically from a peak of 602 in 1977 to 159 in 1980. Little wonder then that poaching is the second most significant cause of wildlife extinction, after habitat destruction.

Our current nature conservation effort smacks of the earlier hunting preserves approach of the aristocrats. It emphasises the preservation of spectacular species like the tiger. This has led to a biased choice of habitats for preservation; thus while the dry and moist deciduous forests are overwhelmingly represented in the national reservations, till recently there were few representatives of either the biologically rich rain forests or the far more threatened thorn scrub habitats. There was also no thought of preserving other groups of organisms such as threatened plants.

The thorn scrub habitat of the semi-arid Deccan, the semi-arid and arid Rajasthan-Gujarat-Punjab belt has suffered the maximum level of destruction. The extinct Cheetah, the Blackbuck, the Wolf, the Great Indian Bustard and the Floricans, all threatened with extinction, belong to this habitat. In spite of this there were few nature reserves in

Smugglers go wild

WWF/A. WRIGHT

A cargo for West Germany marked "handicraft items", seized by suspicious officers of the Department of Revenue Intelligence in Calcutta a few months ago, revealed 68,000 snakeskins and 554 other skins valued at Rs 29 lakhs. Hill maynahs, perhaps the best avian mimics, sold for £15 apiece in England in 1975 and for £120 each in 1979. British import records revealed license applications for over 15,000 orchids from India in 1978, but Indian authorities did not record any plant material exports that year.

The above examples attest to the flourishing but illegal trade in wildlife. The export of raw snakeskins was first banned in 1976, although the ban was lifted intermittently until 1979 "to allow for export of existing stocks". In January 1978 exports of popular bird species, including hill mynahs, was prohibited. Orchids' trade is supposed to be strictly controlled under the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) to which India is a party.

India is a major exporter of wildlife. Commerical interest is mainly confined to products of wild animals such as skins, furs, feathers, ivory, musk, tortoiseshell and rhinoceros' horns. After habitat destruction, poaching is the most significant cause of wildlife extinction. Among live fauna, the bulk of the trade is in birds; estimates of annual bird exports range from two to 4.5 million. The export of live rhesus monkeys was halted in 1978 after protests that many were being used in testing of military weapons.

In 1976, before the ban on the trade of raw snakeskins, Indian dealers sold 3.5 million reptile skins overseas, including over three million snakes. Japan was the biggest importer followed by France, Italy and West Germany.

The skins of the big spotted cats fetch a pretty price — £124,270 for a clouded leopard skin and £94,750 for Bengal tiger skin in the Japanese market, according to a report in "Business India" last year. Strict protection of the big cats has forced traders to go after smaller animals like lynx, fox, jackal and wolf.

The rhinoceros, whose horn can sell upward of Rs 60,000, is a victim of greedy poachers. Despite strict surveillance, 15 rhinos were killed for their horns by poachers in the Kazhiranga National Park in Assam in the first four months of 1982. Japan, the biggest international market for wildlife products, imported about 150 kg of musk from India at Rs 40,000 a kg, in 1980. A single musk deer's glands secrete at most 40 gm of musk

The wanton exploitation of wildlife for commercial purposes is an international problem. In 1973, 21 countries signed the Convention (CITES) which prohibits trade in rare or nearly extinct species (listed in Appendix I,) restricts export of endangered species (listed in Appendix II), and also regulates trade in wildlife products. Over 70 nations, including India, have signed it so far.

A directive issued by the Commerce Ministry in 1979, has brought the Indian Wildlife (Protection) Act closer in line with CITES. This directive bans the export of all forms of Indian wildlife and their products except for 21 bird species, live striped squirrels and the products of six wild animals. The latter include peacock feathers, porcupine quills and the skins of the common fox, the hill fox, the jackal and the jungle cat.

Legal efforts have been none too successful in ending the illegal trade. The most important reason is that profits are lucrative and punishment is often negligible. Ivory sells at Rs 1000 per kg and tusks of a large Indian male elephant weigh about 60 kg. Over 60 nurseries in Darjeeling and Kalimpong, each earn over Rs 40 lakhs a year from the illicit orchid trade, according to a news report. The punishment for illegal poaching/trade may be imprisonment from six months to six years and a minimum fine of Rs 500.

The number of persons prosecuted for violating the Wildlife (Protection) Act fell from a peak of 602 in 1977 to 159 in 1980. This may also indicate successful evasion of the law by traders. Wildlife trade is big business. Customs officials are bought by international racketeers. Last year, an illegal consignment of 70,000 snakeskins worth Rs 40 lakhs seized at the Calcutta docks, led to the suspension of a number of customs officers. Poor people in the country side do the killing, trapping or flower-picking for a nominal price. Khasi tribals earn Rs 20 for two baskets of orchids, which will eventually sell for over £300 (Rs 2700) in the USA.

Customs people are often ill-trained and have a low level of awareness of the CITES regulations. Few of them have the botanical expertise to spot a wild orchid stuck in a pot and labelled as nursery-reared. The convention does not demand a specialised enforcement agency or any mechanism to deal effectively with smugglers.

this habitat type till the recent establishment of the Desert National Park in Rajasthan.

An older nature reserve in this habitat type is the Ranebennur Blackbuck sanctuary in Karnataka. The management of the Ranebennur sanctuary brings out the limitations of the old method. Here the scrub vegetation is being converted to eucalyptus, as if the only aim of conservation is the maintenance of the Blackbuck population. This is also seen in the practice of removing all so-called mature trees from our sanctuaries. These older trees, with their nest holes for such birds as hornbills, and their rotting bark full of insects, are significant for the preservation of overall biological diversity.

Project Tiger is a spectacular landmark in our efforts at wildlife conservation. A serious flaw in this approach, however, is highlighted by the situation in the Periyar Tiger Reserve. Here, several tribal villages were shifted out of the core zone. Dispossessed of their habitat, the tribals soon lost the little land they were given as compensation, and became pauperised. At the same time, the authorities did not remove four cardamom estates in the heart of the core zone. Such happenings and the recent reports of poaching by high officials in the Corbett Tiger Reserve, lend colour to the view that all this so-called conservation effort is exclusively for the benefit of the elite of this country. This attitude converts the local population into enemies, instead of allies of conservation.

Innovative trends

The need to preserve overall biological diversity, rather than

The Blackbuck is a species indigenous to India. Its thorn scrub forest habitat in arid and semi-arid regions has suffered the maximum level of destruction. (Sharad Gaur)

with efforts for water and soil conservation, for reforestation in areas adjoining the reserves, and other programmes of rural development. Scientists gathered at the Indian Institute of Science in Bangalore for a workshop on the conservation and management of biological diversity in March 1982, asserted that the major challenge is to involve the forest dwellers in such conservation programmes. By bringing direct benefits to the local people, eco-development can make them allies in preservation efforts.

just the game animals, is a new concept which is only now being incorporated into our conservation programmes. The credit for this goes to our agricultural scientists who have realised the value of maintaining the genetic resources of indigenous varieties of crops and livestock, wild relatives of domesticated plants and animals, and biological control agents of pests and diseases. A few years ago, the high-yielding rice crop of Indonesia was threatened by the brown-leaf hopper pest. Genes for resisting it were located in the native rice variety from Pattambi in Kerala and a major agricultural disaster was averted. Many species of lower life forms, mites for example, are so little known that we cannot even begin to list the threatened species. In all probability many unknown plant species are also endangered. The approach that must be taken, therefore, is to try to preserve at least one or two examples of each biological community type in the country.

A major effort in this direction is the Biosphere Reserve programme, launched on a worldwide scale by UNESCO in 1973, as the Man and Biosphere (MAB) Programme. It has led to the creation of over 200 biospheres in about 40 countries so far. The Sixth Plan has directed the Department of Environment (DOE) to constitute a cadre of specialists for management of the Biosphere Reserves. Seven areas are being considered for setting up such reserves. They include Nilgiri at the trijunction of Karnataka, Kerala and Tamilnadu, Tura citrus gene sanctuary in Meghalaya, Namdapha in Arunachal Pradesh, Valley of Flowers-Tunganath-Rudranath in UP, Nandadevi in UP, some islands in the Andaman-Nicobar group and the Gulf of Manaar on the Tamil Nadu coast.

The most significant aspect of India's Biosphere Reserves Programme is the concept of eco-development. It is an attempt to integrate the restoration of degraded habitats with efforts for water and soil conservation, for reforestation in areas adjoining the reserves, and other programmes of rural development. Scientists gathered at the Indian Institute of Science in Bangalore for a workshop on the conservation and management of biological diversity in March 1982, asserted that the major challenge is to involve the forest dwellers in such conservation programmes. By bringing direct benefits to the local people, eco-development can make them allies in the preservation efforts.

GOVERNMENT

- *In the last few years, a number of environmental institutions have been established. Besides the National Committee on Environmental Planning (NCEP) and the Department of Environment (DOE) at the Centre, a few States have also set up their own departments of environment.*

- *An Environmental Information Service (ENVIS) has been proposed for the collection, processing and dissemination of environmental information.*

- *The NCEP and the DOE face several hurdles in carrying out environmental impact analysis of development projects. They lack adequate authority, data and qualified personnel.*

- *There are basic flaws in environment protection related laws. When the legislation is adequate the implementation is poor, according to an official review.*

- *Increasing levels of pesticide residues are being recorded in foodstuffs, animal tissues and human fat. The use of pesticides like DDT and BHC, which are in disfavour all over the world, has not been discouraged despite the Insecticides Act of 1968.*

- *The Government has yet to develop an explicit national policy on the environment.*

11

GOVERNMENT

The Government of India has in recent years become increasingly conscious of the environmental crisis engulfing the country. Several new laws have been enacted and outdated ones revised; a new Department of Environment has been set up; and special significance has been accorded to environmental issues in the Sixth Five Year Plan. The last few years have been a period of institution building in this field. A few States, namely, Karnataka, Uttar Pradesh and Madhya Pradesh have set up their own departments of environment.

The need for integrating environmental factors into the process of planned economic development was officially first voiced during the formulation of the Fourth Plan (1969-74). The plan document stated: "Planning for harmonious development recognises the unity of nature and man. Such planning is possible only on the basis of a comprehensive appraisal of environmental issues. There are instances on which timely, specialised advice on environmental aspects could have helped in project design and in averting subsequent adverse effects on the environment leading to loss of invested resources. It is necessary, therefore, to introduce the environmental aspect into our planning and development."

This was in many ways advance thinking. Worldwide consciousness on environmental issues increased in 1972 after the United Nations-organised conference on the Human Environment in Stockholam. A National Committee on Environmental Planning and Coordination (NCEPC) was set up in that year in India to act as a high level advisory body to the Government. With the formation of the Department of Environment, the NCEPC's name has now been abridged to National Committee on Environmental Planning (NCEP). The work of the NCEP includes environmental appraisal of development projects, human settlements planning, surveys of natural ecosystems like wetlands, and spread of environment awareness. At the suggestion of the NCEP, environmental boards have been set up in various States and Union Territories.

Recognising the limitations of an advisory body in ensuring the coordinated implementation of environmental programmes, the Government appointed in February 1980 a high-powered committee to suggest administrative and legislative reforms to improve environmental protection work in the country.

This committee, headed by the then Deputy Chariman of the Planning Commission, Mr N.D. Tiwari (and, hereafter, referred to as the Tiwari Committee) recommended the creation of a separate Department of Environment (DOE) which was created in November 1980 to act as a nodal agency for environmental protection and ecodevelopment work and to carry out environmental appraisal of development projects. It has also been given administrative responsibility for pollution monitoring and regulation and conservation of marine ecosystems and critical ecosystems designated as biosphere reserves.

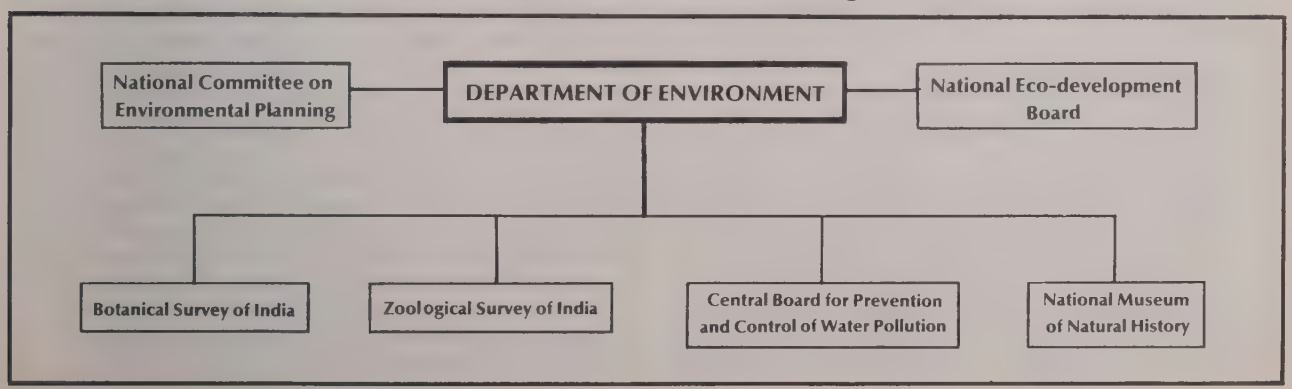
Environmental research studies

During the eight years of its existence, the NCEP has initiated serveral activities

Under the terms of reference assigned to it, a major objective of the NCEP is: "Promoting research in environmental problems and establishing facilities for such research wherever necessary."

Research provides important baseline data about the country's changing environment and identifies new trends. The NCEP implements its research programme through the Indian National Man and the Biosphere Committee (MAB) and the Environmental Research Committee (ERC). The general areas of environmental pollution and its impact,

How the Department of Environment is organised


National Committee on Environmental Planning
DEPARTMENT OF ENVIRONMENT
National Eco-development Board
Botanical Survey of India
Zoological Survey of India
Central Board for Prevention and Control of Water Pollution
National Museum of Natural History

environmental aspects of human settlements, rural environment and other related subject areas are covered by ERC. The ERC also encourages action and demonstration projects which help to transfer research results to the field.

The Man and the Biosphere Programme is a part of an international effort initiated by UNESCO. Its primary objective is to study the impact of human interference on natural ecosystems. So far, over 120 projects have been funded through MAB and ERC.

During 1981-82, the MAB Committee initiated steps to establish an institute of Himalayan Ecology and Development which will emphasise the conservation of the region's rich biological heritage. The committee is also preparing a status report on how the anti-desertification technologies developed by the Central Arid Zone Research Institute in Jodhpur and other organisations can be transferred from the laboratory to the field to improve the ecology of the Rajasthan desert. Another sub-committe is preparing a document outlining a rational policy for the conservation and management of the country's flora and fauna.

The NCEP has sponsored projects on various other environmental problems of national importance such as a project to investigate the long-term environmental impact of the Idukki Dam in Kerala and a project to study the ecological impact of the Beas-Sutluj Link. An all-India coordinated programme for studies on heavy metal pollution is also going to be launched soon. An expert group which studied environmental problems in mining operations has published a state-of-the-art report on mining and environment providing future guidelines for mining authorities. Another expert group is now researching environmental problems in the metallurgical industry.

In addition, several other agencies, such as the University Grants Commission, Council for Scientific and Industrial Research and the Department of Science and Technology have funded a number of research projects of environmental interest. The Planning Commission has recently tried to involve universities situated in the Himalayas and the Western Ghats and along the Ganga in environmental studies. These universities have a student and faculty strength of more than a million.

The involvement of students in these programmes is planned at two levels. While postgraduate scholars will be assigned research problems relevant to the local environment, undergraduate students will undertake mass social action programmes like afforestation, soil conservation and environmental awareness.

Apart from gathering useful data for policy formulation, this could create awareness in the youth about environmental problems.

Environmental impact assessment

The NCEP and the DOE have introduced environmental appraisal of projects of a varied nature and magnitude. If a proposed development project is expected to have an unfavourable environmental impact, the Department of Environment generally constitutes a multi-disciplinary ad hoc committee (expert group or task force) with members drawn from different disciplines and institutions, including a representative of the development agency whose project is under review. Although the recommendations of the committee are not binding on the Government, due attention is paid to them. One of the earliest exercises of the NCEP in environmental appraisal was the Thal-Vaishet fertiliser project which was to be set up near Bombay (see box in chapter on Atmosphere). A similar exercise was conducted for the 5000 tonnes per year DDT plant in Rasayani, Bombay. Adequate pollution abatement technology was made mandatory before the project was cleared.

Perhaps the NCEP's most successful effort was its intervention with the Tamil Nadu State Government on the construction of a hydroelectric project in the heart of the Mudumalai Wildlife Sanctuary in the Nilgiris. An NCEP team visited the area and convinced the State Government that ecological damage would far outweigh the advantages. Another NCEP task force has submitted recommendations to the State Governments situated in the Western Ghats. This region plays a vital role in the climate-water regime of a large hinterland, spread over the States of Maharashtra, Kerala, Karnataka and Tamil Nadu. Several large-scale projects on mining and power generation are under construction in the Western Ghats and these activities will have significant ecological repercussions unless proper safeguards are ensured.

The NCEP and the Planning Commission have already prepared questionnaires for environmental impact assessment of industrial projects, construction of roads and railways, mining projects and hydroelectric and irrigation projects.

The department is facing several problems in carrying out these assessment exercises. "Impact assessment", according to the latest annual report of the department, "demands collection of data on conservation, pisciculture, health effects, afforestation, etc. This data collection is a time-consuming process even when the requisite information is readily available. In many cases, however, data needs to be generated afresh thereby making the appraisal a rather slow process." Data collection requires coordination with agencies like the Botanical Survey of India, Zoological Survey of India, Central Forestry Commission, Central Public Health and Environmental Engineering Organisation, Central and State Prevention and Control of Water Pollution Boards, academic and research institutions. Combining the large amount of information available for meaningful decision often becomes difficult.

Available data also has to be handled carefully. The cost-benefit analysis, for instance, if used in a biased manner, can generate completely lopsided results. Incomplete and fragmented understanding of the situation can also lead to a bias. There is a dearth of professionals who have received training in making an environmental impact analysis.

By the end of 1981-82, the Department of Environment had been referred a total of 183 hydroelectric and irrigation projects.

With the promulgation of the Forest (Conservation) Act, 1980, consideration of projects that involve use of forest land either for submergence or for rehabilitation purposes also requires clearance from an Advisory Committee set up by the Department of Agriculture and Cooperation in the Ministry of Agriculture. Some 54 river valley projects have so far been appraised by the department and safeguards recommended for mitigating environmental damage.

During 1981-82, the DOE also received 23 proposals for thermal power plants. For superthermal power plants of

Assessing environmental impact

The siting of development projects has emerged as a major subject of public controversy over the last few years. Citizen groups and environmentalists have protested against the siting of the Thal-Vaishet fertiliser project near Bombay and dams at Bedthi, Silent Valley and Tehri.

To control further environmental degradation of the country, the Department of Environment has started analysing the environmental impact of development projects. Before the department was formed in 1980, the National Committee on Environmental Planning would undertake the environmental impact assessment (EIA) of controversial projects through specially constituted task forces. Now, however, the department is trying to streamline this procedure.

"For hydroelectric and irrigation projects, thermal power plants, mining operations and shipping and harbour projects, we have prepared questionnaires and set out clear guidelines," says Dr. D.K. Biswas, the officer-in-charge of environmental impact analysis in the DOE. Answers to these questionnaires are screened by DOE officials and recommendations are set out for implementation by the project authorities. This approach helps project authorities to incorporate environmental considerations right at the stage of preparing the project feasibility report.

The DOE, however, faces numerous problem in conducting these exercises well. First, as Dr Biswas explains, "There is no act or legislation by virtue of which the DOE can ask the project authorities to send their project for clearance." At the moment, the Planning Commission passes on projects to the DOE for environmental clearance before it clears them itself. The Prime Minister has also instructed all Ministries that their projects ought to be cleared by the DOE. This leaves the private sector projects out of the department's net, though, of course, nationalised banks or industrial licensing authorities can force an industrial firm to get its project suitably checked.

Secondly, Dr Biswas argues that bringing a project for environmental impact assessment at the final stage merely delays the project and may not necessarily stop it. With only a handful of officials in DOE looking after EIA, it is impossible to assess the number of projects being planned in the country.

Unnecessary delays in project awaiting EIA clearance is the worst thing that can happen to the growing environmental movement in a developing country, feels Dr Biswas. India needs rapid industrial and agricultural growth and such delays will only be economically harmful and will create a strong backlash against environmentalists. Dr Biswas says, "India cannot follow the US pattern of environmental impact assessment where detailed studies are carried out to assess each project. The best thing would be to have a clear list of dos and don'ts which each project manager should be aware of and can build on into the project ;at the initial preparatory stages."

For instance, there should be clear idea of what ecosystems can be tampered with and to what extent, and which ecosystems simply should not be touched, says Dr Biswas. This would make project preparation, planning and execution much simpler. This requires the generation and collection of enormous amounts of data, the lack of which is a major cause of delays in EIA at the moment. Extensive studies need to be undertaken on representative ecosystems like the Western Ghats, Northeastern India, Doon Valley or the Bastar region to get a good idea of the optimum level of interference permissible. This calls for massive research by our scientists, especially biologists. Unfortunately few scientists in India have studied biology from an ecosystem viewpoint. Botanists, for instance, have concentrated more on the taxonomy (i.e., classification of plants).

The DOE still has to build up a good machinery to monitor how the environmental safeguards recommended by it are being implemented. Environmental consciousness remains low in the Government. Though the Tiwari Committee had recommended that each Ministry should form its own environment cell, till date no Ministry has yet done so.

about 1000 MW capacity, the concerned authorities have been asked to provide detailed environmental impact statements. The department encourages the utilisation of flyash but where this is not possible, project authorities have to ensure that it does not contaminate groundwater or neighbouring agricultural fields.

The department has also formulated guidelines and questionnaires for assessing the environmental impact of different types of industries. All the Central Ministries have been instructed to include anti-pollution measures into the outlay of public sector projects.

For dealing with projects of special importance the department has set up several expert groups and task forces. These include: a Board for Doon Valley and adjacent watershed areas of Ganga and Yamuna under the chairmanship of C.P.N. Singh, Minister of State for Environment; a study group on the environmental aspects of the proposed rail-cum-road link between old and new Bombay; a high power committee for pollution control in Agra-Mathura Region to protect the Taj Mahal; a joint committee on Silent Valley; a working group for studies on the Tehri Dam Project; a working group for environmental impact assessment of Heran Reservoir (Lalpur Dam) Project in Gujarat; a monitoring committee for long-term environmental impacts of multipurpose river valley projects in Kerala; and a monitoring committee to ensure the implementation of environmental safeguards in four major public sector projects in Bombay, namely Sasoon Dock, Thal-Vaishet fertiliser Township, Nhava-Sheva Port, and the Oil and Natural Gas Commission's base and offshore drilling platform at Nhava.

Nature conservation

A key nature conservation programme of the DOE is the identification of 19 potential areas in the country as Biosphere Reserves. The Nilgiris in the Western Ghats, Namdapha in Arunachal Pradesh and Tura Gene Sanctuary in Meghalaya have been surveyed in detail. The Valley of Flowers and Nandadevi, both in the UP Himalayas, are also being studied.

A map on important wetlands and wildlife in various regions of the country has also been prepared. The wetlands (shallow water bodies) constitute a resource of great economic, cultural, scientific and recreational value. In addition to their ecological functions as regulators of water regimes, many wildlife, such as waterfowls, depend on these water bodies for their survival. A nationwide survey of the wetlands has collected baseline information on the nature and distribution of wetland ecosystems in the country. An expert committee has evaluated the information and suggested suitable areas to be designated as waterfowl habitats of international importance.

A survey of aquatic weeds has assessed the nature and magnitude of problems in different parts of the country. The explosive spread of noxious weeds like *Salvinia* in water bodies interferes with the efficient utilisation of the country's water resources. Increasing pollution loads through indiscriminate discharge of industrial effluents and run-off from agricultural fields, has aggravated this situation. Building dams, reservoirs and irrigation networks has also provided new habitats for noxious aquatic weeds.

The department proposes to identify and entrust an agency with the task of monitoring and planning for the conservation of the nation's valuable marine ecosystems. This agency will be adequately strengthened to conduct research on the prevention of marine pollution, rational exploitation of marine resources and protection of valuable areas and species of marine life.

Ecodevelopment programmes

To incorporate environmental concerns in development planning, the NCEP has encouraged governments of States and Union Territories to set up environmental boards which will act as nodal agencies within the region. High-level boards have been set up by various States. At the Centre, a National Ecodevelopment Board was constituted in August, 1981, consisting of several scientists and senior bureaucrats from departments dealing with energy, rural reconstruction, irrigation, space, defence, environment, forests and planning. The board is an advisory body and its task is to identify critical ecosystems, especially in hilly regions. It will prepare detailed operational blueprints of projects which not only conserve the ecology but also meet the needs of the local people.

The Department of Environment, with other governmental and non-governmental bodies is also sponsoring a number of field action programmes which try to demonstrate successful tools, techniques and methodologies for environmental protection. Projects include tree planting, weed eradication, community waste and refuse collection, "cleaning" of water bodies, and the involvement of local communities in the protection of forests, wildlife, etc. Projects involving the youth in ecodevelopment activities through summer camps are also being planned. The department emphasises that it will support voluntary organisations through grants-in-aid.

To accelerate the process of afforestation in the hills, an Ecodevelopment Force consisting of ex-servicemen is being set up. This force will have discrete units which will be deployed, to begin with, in the upper catchment areas of major Himalayan river systems. They will take up afforestation and soil conservation programmes and also assist in harnessing rainwater for subsequent use for domestic and agricultural purposes.

The DOE is also organising ecodevelopment camps for university students with specific goals, such as the repair of a damaged ecosystem, setting up of a national marine or desert park or a biosphere reserve, organisation of a village fuelwood plantation etc. For each camp, selected students drawn from different universities will be trained before the work of the camp is started.

Environmental information

An environmental information system (ENVIS) for the collection, processing and dissemination of environmental information to aid planners, decision-makers and researchers, has been proposed in the Sixth Plan. To avoid duplication of effort (particularly in fields such as natural resources management, where several agencies are already serving as repositories of information), the system will work on a distributed data-base concept. A Documentation and Publication Centre will regularly bring out status reports, research monographs, and case studies.

Plans are also afoot to make a comprehensive inventory of ecological resources in the country. This will be done in coordination with the environmental quality monitoring and environmental information system programmes and done in phases by using the existing institutions, such as, the Survey of India, the Botanical and Zoological Surveys of India, the National Remote Sensing Agency, etc. Data gathered from satellite pictures, aerial photography and field surveys will be available to planners and decision makers.

Laws and their implementation

In accordance with the Directive Principles (Articles 48 and 51-A) of the Indian Constitution, the protection and improvement of the natural environment (including forests and wildlife) is an obligatory responsibility of the State and of every citizen of India. The overriding concern for ecological security has also been stressed in the National Policy for Economic Development.

Several laws have been enacted from time to time which are directly or indirectly related to environmental protection. Among them, the more recent ones are the Insecticides Act 1968, Wildlife Protection Act 1974, Water Pollution Cess Act 1977, Forest (Conservation) Act 1980 and the Air (Prevention and Control of Pollution) Act 1981. Some of the older laws, such as the Indian Forest Act of 1927, are now under review.

In August 1981, the Department of Environment took charge of pollution monitoring and regulation. It is now administratively responsible for implementing the Water Pollution Control Act of 1974 and the new Air Pollution Control Act. The DOE is also setting up a legal wing to examine and draft necessary legislative provisions to establish biosphere reserves, protect grazing lands, wetlands and catchment areas, exploit coastal waters and control toxic substances.

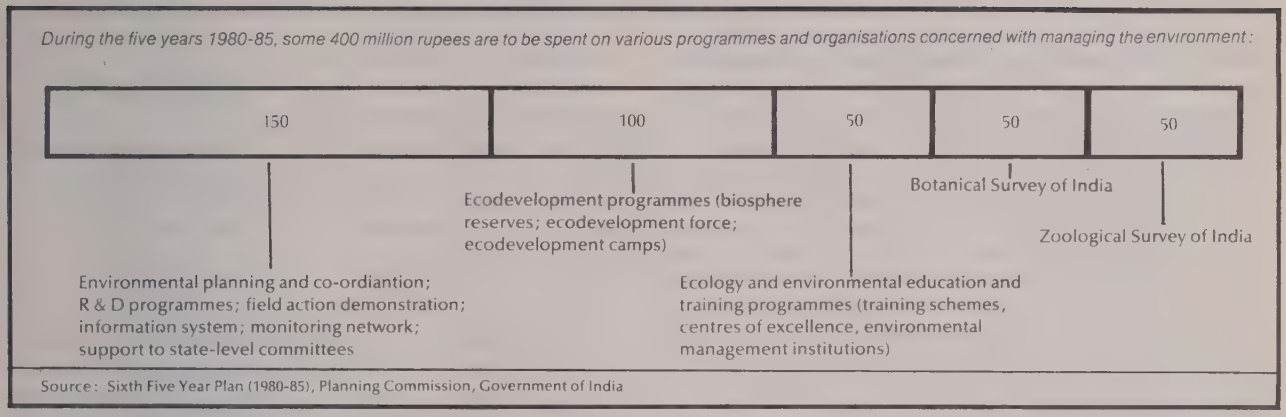
While these developments have removed some legal hurdles in the path of environmental protection, several problems persist. Justice Nagendra Singh, President of the Indian Academy of Environmental Law, Conservation and Research suggests that as environmental protection is of national importance Parliament should initiate legislation to cover all aspects of environmental pollution throughout the country in an integrated manner. As these measures would include many subjects in the State list — there are only a few subjects in the concurrent list directly relating to environment — he feels a specific entry should be made in the Central list on the subject so that legislative measures and executive action can be taken by the Centre.

Professor Madhav Gadgil of the Indian Institute of Science further points out that there are several areas where legislation is inadequate. "Major lacunae in our environmental legislation include measures to prevent overexploitation of fisheries, a legal provision for taking over the treatment of industrial effluents by the Government and preservation of landscapes of special significance".

A broad survey of 30 legislative enactments related to the protection of the environment, conducted by the Tiwari Committee, revealed some basic flaws in these laws.

Many existing laws primarily promote development and resource utilisation for specific economic benefits without careful analysis of the potential short and long term deleterious effects on the environment.

Figure 1. The Sixth Plan's outlay on environmental management.


During the five years 1980-85, some 400 million rupees are to be spent on various programmes and organisations concerned with managing the environment:
150
100
50
50
50
Botanical Survey of India
Ecodevelopment programmes (biosphere reserves; ecodevelopment force; ecodevelopment camps)
Zoological Survey of India
Environmental planning and co-ordiantion; R & D programmes; field action demonstration; information system; monitoring network; support to state-level committees
Ecology and environmental education and training programmes (training schemes, centres of excellence, environmental management institutions)
Source: Sixth Five Year Plan (1980-85), Planning Commission, Government of India

Several laws relating to the management of environmental resources do not clearly state the social objectives they aim to achieve. Consequently the interpretation of the administrative machinery implementing the legislation is often not in conformity with the intent and purpose of the law.

Some laws, particularly on land use and management of environmental resources, appear to be accomplishing self defeating social objectives. Where such resources are shared by more than one State, legislation enacted in one State may have adverse environmental implications for a neighbouring one.

In several cases where legislation is adequate, the Tiwari Committee's survey found that implementation leaves much to be desired.

For instance, regarding the implementation of the Insecticides Act, 1968, which regulates all aspects of the use of pesticides, the committee has said that it has not "encouraged strongly enough the move away from the use of organochlorine pesticides (like DDT and BHC) which are in disfavour all over the world for their proven detrimental effects on the various living natural resources of the environment". It has further said that the provisions in the Act for monitoring pesticide residues in the environment have been "totally inadequate", and therefore it is not surprising "that increasing levels of pesticide residues are being recorded in foodstuffs, animal tissues and even human fat". Pests like the malarial mosquito are also becoming resistant to chemical pesticides.

The committee was equally strong in pointing out the laxity in the implementation of the Water (Prevention and Control of Pollution) Act, 1974, which has been enacted at the Centre and adopted by 14 States. Although Central and State boards for the prevention and control of water pollution were set up, the committee noticed that practically none of them received adequate support. Many of them had become "weak appendages of the respective Public Health Engineering Department in the States" because of the provision in the Act requiring the Member Secretary of the Boards to be a public health engineer on deputation. Furthermore, the very same boards would be required to implement the Air Pollution Control Act which would place "further demand on the resources and expertise of the Boards for which adequate thought has not been given". The committee also pointed out that prosecuting violators in regular judicial courts for violating the Water Pollution Act would involve time and would be ineffective in preventing the violater from causing further pollution while the case was *sub judice*.

A serious problem in implementing these laws is that the importance attached to environmental protection is of such recent origin that it has not yet penetrated deep into the Government, and officials continue to work with the same glaring neglect of environmental factors as before. The handful of officers in DOE are not in a position to remedy this large-scale neglect spread over so many projects and regions.

THE CHALLENGE BEFORE DOE

The NCEP and DOE have begun their task of managing the country's environment by focussing on the development of important management tools such as research, collection and dissemination of environmental information, and assessment of environmental impact of projects.

However, if environmental considerations are to become a rule and not an exception in government work, the NCEP and DOE will have to ensure that environmental awareness spreads also to other bureaucracies within the government. This is certainly not proving to be easy at the moment.

As Thomas Mathew, a former official of the DOE and now director of the Environmental Service Group of the World Wildlife Fund-India, points out that NCEP and DOE have not yet been able to establish any credibility with other Ministries and departments. The NCEP and DOE, thus, remain as agencies which formulate "guidelines for environmental analyses 'in the air' with little substantive relevance to the hard realities of the development process and multi-faceted administrative support systems," says Mathew.

"The main reason for the failure of the State (environment) committees" he says, "was that environment" was seen by the State Governments as another sector of development, that is, another subject area for which fresh allocations of people, money and materials had to be provided for within already overstrained budgets. Environments was, therefore, never considered as a kind of new management approach that needs to pervade every existing sector of the economy."

Working under the direct charge of the Prime Minister, the DOE has certainly acquired a high degree of authority within the Government but the diffusion of environmental consciousness within the labyrinthine structure of the Government does remain excruciatingly slow. In the absence of a widespread recognition of urgency on environmental issues, even the process of institution building for environmental preservation remains retarded. Though the Tiwari Committee, for instance, had strongly recommended that every Ministry should set up its own environment cell, no Ministry has yet done so. The important proposal to set up a Central land Commission, which will undertake programmes to prevent further deterioration of the country's precious soil resources and encroachment of agricultural land by towns and industries, also remains caught up in bureaucratic tangles, such as, which Ministry ought to control such an agency. A government-wide recognition of environmental problems, thus, has yet to come.

Most important of all, the Government has yet to develop an explicit national environment policy which is more than just a set of isolated programmes carried out by a few isolated government agencies. There will be far more to a country's environment policy than just a policy for environmental conservation. Good national environmental management will basically good, rational, egalitarian resource management, which will have to answer a number of wider social and economic questions: for instance, when and why does the Indian society consider one thing a resource and another a useless, waste product? How can this be changed, when and where necessary? Who controls the current pattern of resource consumption? Who benefits from it? Are natural resources going to be used mainly for the benefit of the rich or also for the benefit of the poor? Are they going to be used entirely for the benefit this generation or will they be kept and nurtured for future generations, too?

Each of these questions bristles with environmental implications. For instance, whether forests are going to be decreed a resource primarily for sale in the rich urban markets or for the subsistence needs of the poor forest people, will greatly determine the nature of forests and forestry in the country and the role that forests will play in environmental protection and in meeting the basic needs of the population. It is possible to take up a massive tree-planting programme but still fail to meet the basic energy needs of the majority of the people. Similarly, whether this society decides to protect its rivers and ponds as resources primarily meant for the people who drink water from it or in its haste for industrial and urban development, it decides to regard them primarily as cheap dumpyards for urban and industrial waste, will again greatly determine what happens to the country's precious water bodies. To take another example: Even though the majority of Indians live in mud buildings, the country's technological system has simply refused to recognise mud as an important natural resource for housing the population. This decision to regard mud as a waste and rely almost exclusively on bricks, steel and cement in official housing programmes has enormous implications for the country's housing policy as well as its environment.

In other words, the country already has a national environment policy implicit in its existing development policy. As this implicit environment policy is obviously inappropriate, a new environment policy has to be outlined and made explicit to the nation but concomitant changes have also to be made in the country's development policy. This means that environmental management cannot be made a matter of pure technocratic solutions. To be handled successfully, it will have to be seen in its full political, economic, social and technological context. In almost every case, the change from environmental degradation to environmental protection will arise out of a change in the pattern of resource-use, and to bring about this change, the change agent will have to be prepared to deal with the economic and political interest groups, that benefit from the current pattern of resource-use.

Public consciousness of and support for environmental issues will, therefore, be a major determinant for good decision-making in field of environment. The DOE and NCEP will clearly have to learn to work closely with voluntary organisations probably more than any other government agency. These institutions will have to repeatedly step on the toes of every other government agency. To be able to get away with this, public; support for their programmes and points of view will be crucial. Working together with voluntary agencies will be equally important for mobilising people to undertake constructive programmes aimed at environmental regeneration.

The DOE has indeed expressed an interest in working with voluntary agencies on several occasions. But the extent to which a government department can become an open institution remains to be seen. There are also serious doubts about the extent to which it will be allowed to become the government's enfant terrible which creates roadblocks for every other agency, raises doubts and points out an alternative — after harder and more difficult — choices in case after case.

The pressure on DOE to become yet another government department which lives in peaceful coexistence with other public and private agencies, will obviously be very high. This the DOE could easily do by carving out its own little niche within the governmental system, restricting itself to little packages, of benign programmes and activities. The proposed Ecodevelopment Force is a good example of a technocratic solution, throught up by a government agency, to the complex social and economic problem of planting trees. The force may dramatically increase the number of trees planted but it with hardly be able to ensure the survival of trees, which can only be done by mobilising and involving the local people in whose interest those trees have been planted.

It must be said, however, to the credit of the Government that official reviews of environmental protection work released in recent years show a readiness to admit certain past mistakes. For example, the Draft Sixth Plan states:

> "The forests under management have ..... been treated from the very narrow viewpoint of production of commercial timber and pulpwood so that they have been rapidly converted to stands of teak, pine or eucalyptus with no thought given for even the maintenance of species producing valuable minor forest produce such as oilseeds.
>
> "Our wildlife conservation efforts have so far been primarily directed to the maintenance of areas with one or more spectacular animals such as the tiger or the rhino. This has led to a total neglect of many other ecosystems which lack such spectacular animals but are rich in floristic reserves.
>
> "So far attempts at environmental improvement in human settlements have come in a disjointed and piecemeal fashion with attention focussed on one particular function or the other (transportation, water supply, power generation, etc.) rather than treating settlements and their activities as a dynamic and organic whole."

If this honesty persists, the progress of official environmental institutions will indeed be interesting to watch over the years.

RESOURCES

LAND

Papers of B.B. Vohra (Chairman, National Committee on Environmental Planning), M.S. Swaminathan (former Member of the Planning Commission and now Director General of the International Rice Research Institute in the Philippines) and J.S. Kanwar (Director of Research at the International Crops Research Institute of the Semi-Arid Tropics in Hyderabad) have been extremely helpful in preparing this chapter. B.B. Vohra's Sardar Patel Memorial Lecture of 1980 entitled 'A Policy for Land and Water' has formed the basis of the material on soil erosion, waterlogging and salinity with more information added from M.S. Swaminathan's Presidential Address to the Indian Society of Agricultural Economics in 1977 entitled 'Indian Agriculture at the Crossroads', his 1981 First Ajudhia Nath Khosla Lecture entitled 'Irrigation and Our Agricultural Future' delivered at the University of Roorkee, and 'From begging bowl to bread basket' which appeared in 'Kurukshetra,' February 1979. A compilation of B.B. Vohra's papers has been prepared by the Training Division of the Department of Personnel and Administrative Reforms, Ministry of Home Affairs, New Delhi. A critique of Vohra's Patel Memorial Lecture has been published by Shekhar Singh of the Indian Institute of Public Administration in two issues of 'Mainstream' (November 21 and 28, 1981).

Data on the depletion of micronutrients in our cultivated soils has come from J.S. Kanwar's Presidental Address to the 12th International Congress of Soil Science held in New Delhi in February 1982. Several useful papers were presented at the Congress, including I.P. Abrol's 'Reclamation of Waste Lands and World Food prospects'; G.S. Sekhon's 'Some Experiences in Soil Fertility Management in India'; K.G. Tejwani's "Soils Policy in India: Need and Direction'; and, H.S. Mann's 'Desertification in India: Past and Future of the Thar Desert'. The Congress was organised by the Indian Society of Soil Science, Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute, New Delhi.

The Congress also produced interesting papers on current research in nonsymbiotic nitrogen fixation, which is aimed at reducing the use of chemical fertilisers, and availability and importance of organic matter in the tropical soils. FAO Soils Bulletin No. 46 entitled "Blue-green Algae for Rice Production: A manual for its promotion", prepared by Dr. G.S. Venkataraman of the Indian Agricultural Research Institute, is a useful reference on blue-green algae. 'Agriculture: Toward 2000' published by FAO provides a good scenario of what agricultural experts believe will happen in the next two decades.

The item on the Sukhomajri village has been prepared by Rajiv Gupta after a visit to the project. He has also referred to the following papers: 'A Rural Development Program in India' by David Seckler and Deep Joshi and 'Conservation, Water and Human Development at Sukhomajri' by Marcus Franda. The latter is available as an American Universities Field Staff Report 1981/No. 13/Asia.

The report on the Mitti Bachao Abhiyan (Save the Soil Campaign) has been written by Anupam Mishra who has also published a detailed report on it in Hindi through the Gandhi Peace Foundation in New Delhi. The note on the Thar Desert has been prepared by Amit Baruah and Sunita Narain based on the Country Report presented by the Indian delegation to the United Nations Conference on Desertification held in Nairobi in 1977 and H.S. Mann's paper referred to above.

WATER

The basic text of the chapter was written by A.K. "Dunu" Roy. The section on 'River Pollution in India' was written by Ravi Chopra and Bharat Dogra.

In compiling this chapter, articles from popular periodicals have provided a useful background. The more interesting articles referred to include: 'The world is running out of water' by Ramesh Chandran in "The Illustrated Weekly of India", April 24, 1977; 'Goa: finished in ten years' by Claude Alvares in "Inside Outside" (date not known), 'Pollution spreads to India's sacred river' by Sunanda Datta-Ray in "Earthwatch", No.3, 1980; 'Deadly pollution of our rivers' by Dhirendra Dixit in "Imprint", August 1981; 'Water Pollution — a peoples' issue', a CSE feature by Ujjayant Chakravorty.

Two recent conferences produced a number of research papers: the 68th session of the Indian Science Congress at Varanasi, January 1981 and the International Symposium on Water Resources Conservation Pollution and Abatement, at Roorkee, December 11-13, 1981. 'Water Pollution and its control in India', a paper presented by N.S. Deodhar and K.J. Nath at Varanasi, contains the statistics from which Tables 1 & 2 are extracted.

Among the papers presented at Roorkee, the following have been consulted: 'Pollution Control for Ganga' by D.S. Bhargava; 'Self Purification Studies on River Khan' by H.D. Bansal et al; 'Wastewater Treatment Using Water Hyacinth' by Pradeep Kumar et al; 'Ganga, the Most Self-Purifying River' by D.S. Bhargava; 'Water Hyacinth: An Aid to Sewage Treatment' by Gyan Sagar and D.S. Bhargava. The proceedings have been published by Sarita Prakashan (36 Netaji Subhash Marg, Daryaganj, New Delhi).

The Central Board for Prevention and Control of Water Pollution (Skylark Building, 60 Nehru Place, New Delhi-19) has produced a number of publications on the subject. We referred to: 'Status of Water Supply and Waste Water Collection Treatment and Disposal in Class I cities of India', a similar volume for Class II cities, and a report on the Union Territory of Delhi.

Scholarly research has also been done by voluntary organizations and universities. Data and information have been obtained from: 'Environmental Planning' a report submitted to the Department of Science and Technology (1981) by the Shahdol Group (c/o Vidushak Karkhana, Anuppur, Shahdol (M.P.)); the 'Report of the Task Force on Environment Part I: the State of the Environment in Kerala' prepared by the Kerala Sastra Sahitya Parishad (c/o Dr M.K. Prasad, 62 Girinagar, Cochin 682020), 'The story of a dying village — a case study of pollution problem', ed V.K. Damodaran published by the Asian Science Communicators' Organization (Calicut); 'Agricultural Pesticides Residues and their Degradation in Soil, Water and a few biota of river Ganges from Allahabad to Patna', Prof Lallan Rai et al, Banaras Hindu University (1979); 'Limnological Survey and Impact of Human Activities on the River Ganges' by K.S. Bilgrami and J.S. Datta-Munshi, Bhagalpur University (1979).

The Central Fisheries Research Institute (CIFRI), Barrackpore, West Bengal, has done a number of studies on the effect of river pollution on aquatic life. Here we referred to 'Aquatic pollution in relation to inland fisheries' by A.V. Natarajan and B.B. Ghosh; 'Inland fisheries of India with emphasis on eastern region and recent trends in aquatic pollution by M.M. Bagchi.

Other papers referred to are: a series of publications on industrial pollution of the Kalu river and the presence of heavy metals in

Bombay's marine environment by Drs B.B. Haldar, S.B. Chaphekar and co-workers (at the Institute of Science, Cama Road, Bombay 400 032); and 'Legal Control of Water Pollution in India' by Prof Asit Bose, Indian Institute of Management, Calcutta.

For the box item on the KSSP, a CSE news feature 'Teaching science becomes social activism' by U.N. Chakravorty has been condensed.

FORESTS

This chapter has been edited by Anil Agarwal. Basic drafts for the various sections have been written by Anupam Mishra, Sevanti Ninan, Kalpana Sharma, Shahnaz Anklesaria, and Anil Agarwal.

The overview has been jointly written by Anupam Mishra and Anil Agarwal. The most important reference in this section is "Forest Resources of Tropical Asia", Food and Agriculture Organisation (FAO) of the United Nations, Rome 1981, and in particular the chapter on India contained in the report. This chapter, compiled by Mr R.N. Saxena, has an enormous amount of data.

For the State of the Forests section, the important references for the Western Himalayan forests are: 'A report on the Kashmir to Kohima Walk' by Sundarlal Bahuguna, covering Jammu, Kashmir and Himachal Pradesh (1981); 'Reforesting the Himalayas', Prem Shankar Jha, The Times of India, New Delhi, October 26 and 27, 1981; information provided by Chandi Prasad Bhatt; 'Eco-System of the Central Himalayas and Chipko Movement; 'Determination of Hill People to Save their Forests', Chandi Prasad Bhatt, Roopak Printers, Delhi, 1980; 'Hugging the Himalayas: The Chipko Experience', edited by Shishupal Singh Kunwar, Dasholi Gram Swarajya Mandal, Gopeshwar, 1982; 'Gandhi's ghost saves the Himalayan trees', Anil Agarwal, New Scientist, London, 14 August 1975; 'Bare Himalaya: A Himalayan Problem', by Gopa Joshi in Gandhi Marg.

The report on the Northeastern Himalayan forests was written by Shahnaz Anklesaria and Kalpana Sharma after travelling in Assam and Meghalaya, interviewing forest officers and university professors, timber merchants, officials from the departments of forests, soil conservation, flood control and revenue, authorities on tribal culture, etc. Professor P.S. Rama Krishnan, head of the Department of Botany in the School of Life Sciences, the Northeastern Hill University, provided valuable information on the impact of jhum on the forests and on Cherrapunjee. Other sources and references include Basic Statistics of the North-Eastern Council, Shillong; proceedings of "Development without Destruction", a symposium held in Shillong in October 1980, and published by the Forest Department, Government of Meghalaya; Economic Survey, Assam: 1980-81.

The review of forests in Central India has been prepared using the following resources: 'Forest Policy and Tribal Development: Problems of Implementation, Ecology and Exploitation', Gopa Joshi, Social Action, October-December, 1981; 'Sal means Jharkhand, saguwan means Bihar', A.K. Roy, Sunday, Calcutta, (sometime in 1979); 'Jharkhand Movement Going Violent ?', by Arun Ranjan in New Delhi (magazine), New Delhi, October 27-November 9, 1980; 'Jharkhand State: Where Adivasis Seek a Haven', Sumi Krishna Chauhan, Earthscan Bulletin, London, May 1981; 'Law of the Jungle in Jharkhand', Janak Singh, The Times of India, New Delhi, February 11, 1982; 'Adivasis' Struggle for Survival', Janak Singh, The Times of India, New Delhi, February 11, 1982; 'Adivasis' Struggle for Survival', Janak singh, The Times of India, New Delhi, February 12, 1982; 'Pine for the Forest ?', Darryl D'Monte, The Hindustan Times, New Delhi, (no date available); 'Parallel Authority by Bastar Tribals', N.K. Singh, The Indian Express, New Delhi, February 6, 1982; 'Save Orissa's forests: Tree-cutting permits run amock', by Amarendra Bose, Sunday, Calcutta, April 6, 1980; 'Save the Simplipal Hill Forests', Amarendra Bose (publication data not available).

The round-up of the Western and Eastern Ghats forests has been written after consulting 'The Report of the Task Force on the Environment — Part I' prepared by the Kerala Sastra Sahitya Parishad (KSSP); 'Vanishing Bamboo Stocks', Madhav Gadgil and S. Narendra Prasad, Commerce, Bombay, June 17, 1978; 'Problems of the Management of Bamboo Resources in Tamil Nadu', S. Ramesh Bhatt, a study sponsored by the Bombay Natural History Society, mimeographed (no date);

The section on social forestry has been written by Sevanti Ninan and Anil Agarwal, using 'Social, Economic and Ecological Impact of Social Forestry in Kolar District', Vandana Shiva, J. Bandopadhyaya, H.C. Sharatchandra, Indian Institute of Management, Bangalore, 1980, mimeographed; 'Beyond the Firewood March', I and II, Jayanto Bandopadhyay, Financial Express, New Delhi, September 1 & 2, 1981; 'The Pernicious Effects of Social Forestry' and 'Social Forestry Destroying Ryots' Life-supporting Systems', by B.V. Krishnamurti, Deccan Herald, Bangalore, November 30 and December 1, 1981; 'The Social Forestry Con Game', Claude Alvares, Deccan Herald, Bangalore, November 11, 1981; 'Reply to Claude Alvares: Social Forestry is not a con game', S. Shyam Sundar (IFS), Deccan Herald, Bangalore, November 18, 1981; 'Rejoinder to Mr Shyam Sundar: Farmers want food, not wood', S.T. Somashekhara Reddy, Deccan Herald, Bangalore, December 1, 1981; 'The Barbed Wire Culture: A Review of the Draft Social Forestry Project in Rajasthan', Col. B.L. Verma, VSM (Retd), a paper submitted at the Workshop on Forest Bill held at Indian Social Institute, New Delhi, April 12-14, 1982, mimeographed.

DAMS

A working draft of the chapter was prepared by Bharat Dogra and re-worked into the final form by Ravi Chopra.

"Major Dams — A Second Look" is a collection of papers presented at a seminar in 1981 to evaluate the impact of river valley projects in the Uttara Kannada district of Karnataka. Papers presented by Dr Madhav Gadgil, Vijay Paranjpye and V.K. Damodaran have been invaluable in writing the sections on Adverse Environmental Effects, Cost-Benefit Analysis and Alternatives, respectively. "Major Dams — A Second Look" is edited by L.T. Sharma and Ravi Sharma and is available from the Environment Cell, Gandhi Peace Foundation, 223 Deen Dayal Upadhyaya Marg, New Delhi 110002.

The Sixth Plan (1980-85) document has provided substantial information for the section "Review of Benefits". In addition, data presented here has been obtained from: The Report of the Working Group on Energy Policy published by the Planning Commission (1979); "Basic Statistics Relating to the Indian Economy" Volumes I and II issued by the Centre for Monitoring the Indian Economy (Kaliandas Udyog Bhavan, Worli, Bombay 400025); the "Register of Large Dams" compiled by the Central Board for irrigation and Power, Ministry of Irrigation, New Delhi.

Readers seeking information on flood disasters may refer to the proceedings of the "International Conference on Flood Disasters" organized by the Indian National Science Academy in New Delhi, 3-5 December 1981.

Two papers, "Government Privilege Claim Rejected" and "Government Delays Commission, Denies Justice" published by the Consumer Education and Research Centre (Thakorebhai Desai Smarak Bhavan, Ellisbridge, Ahmedabad 380006) provided the story on the efforts of Gujarat Government to suppress the findings of the Inquiry Commission on the Macchu Dam Disaster. The Gopinatham tragedy was first highlighted in a photo-feature by Bhawan Singh in "India Today", November 15, 1981. The Karnataka Public Accounts Committee submitted a scathing report to the State Legislature in January 1982. After a thorough investigation into this tragedy.

Dr Madhav Gadgil's paper "Hills, dams and forests. Some field observations from the Western Ghats" presents an excellent analysis on the impact of dams on tribals and their environment. It is available from the Centre for Theoretical Studies, Indian Institute of Science, Bangalore 560012.

For topical information, a number of newspaper articles have been referred to. The more notable ones are: "New threat to the valley of flowers" by Chandi Prasad Bhatt, The Times of India, New Delhi, April 26, 1982; "Times Up for Tehri" by Darryl D'Monte, Indian Express Magazine, August 30, 1981; "Power transmission loss" by O.N. Kaul, Economic Times, Bombay, October 5, 1981.

The box item on Srisailam dam has been prepared by Ravi Chopra using a report of the fact-finding team sponsored by the Lokayan Research Project (13 Alipur Road, Delhi 110054) and a newsreport, "A forced exodus: Srisailam Dam" in India Today, New Delhi, July 16-31, 1981.

"Is Tehri a time-bomb" has been written by Kalpana Sharma based on a field report submitted by Navin Juyal and papers presented at the seminar on Tehri High Dam organized by the Himalaya Seva Sangh, New Delhi, March 1981.

Ravi Chopra has written the item on the Silent Valley hydroelectric project after consulting Dr. M.S. Swaminathan's report "Development of the Silent Valley Reserve Forest, Kerala" submitted to the Ministry of Agriculture and Irrigation (1979) and a monograph "The Silent Valley Hydroelectric Project" published by the Kerala Sastra Sahitya Parishad (July 1979).

"Damming the Tribals" was written by Anil Agarwal from another field report filed by Navin Juyal.

ATMOSPHERE

A draft of the section on air pollution was written by Darryl D'Monte and extra material was incorporated by Ravi Chopra and Shyam Jha.

The World Health Organization (WHO) in Geneva and the United Nations Environment Program (UNEP) in Nairobi are good sources for information and data on air pollution. The sources we consulted are: "Manual on urban air quality management", WHO regional publications, European series no. 1 (1972); "Preparatory documents — Conference on the Human Environment", Stockholm (1972); "The World Environment Report 1972-82" a report by UNEP (1982).

Hard data on air quality and its effects is extremely limited. The data in "Air Quality Index of Selected Indian Cities", published by the National Environmental Engineering Research Institute (NEERI, Nehru Marg, Nagpur 20) is frustratingly scanty. Two other government documents have been referred to: the Sixth Plan (1980 - 85) document and India's country report presented at the Stockholm Conference in 1972.

Some papers read at the "Annual Conference on Air Pollution '82" organized by the Institute of Energy Management, Bombay (Feb '82); the seminar on "Air Pollution and Control" sponsored by the All-India Manufacturers' Association, Bombay (January '82) and the "Seminar on Environmental Problems of Delhi" have been useful.

For topical information, a number of newsclippings from the CSE files were referred to. In additon, local issues have been gleaned from "Amdavadma" the city-magazine published by the Vikram Sarabhai Institute for Development Interaction (VIKSAT, Vastrapur Road, Thaltej Tekra, Ahmedabad 380054) and "Scavenger", the monthly journal of the Society for a Clean Environment (SOCLEEN, Garden Resort, 606 Sion-Trombay Road, Chembur Bombay 400071).

The box items "Painted black" and "The polluted and the dying" have been condensed from newsreports in "India Today". "Requiem for the Taj" was prepared by Shyam Jha, using notes written by Darryl D'Monte and articles by A. Mahadevan in "Readers' Digest" and J.M. Dave in "The Illustrated Weekly of India", January 14, 1979. "The Noise Nuisance" has been contributed by Shyam Jha.

"Plants and air pollution" was also written by Shyam Jha on the basis of a report, "Effects of Industrial Air Pollutants on Plants", by Dr S.B. Chaphekar and co-workers (Department of Botany, Institute of Science, Bombay). Another detailed review on the subject is "Air Pollution and Plants" by T.N. Khushoo and K.J. Ahmed in "Impact of the Development of Science and Technology on Environment", edited by A.K. Sharma and A. Sharma and published by the Indian Science Congress Association, 14 Dr Biresh Guha St, Calcutta.

The carbon dioxide section is based on a text written by Professor S.K. Sinha of the Indian Agricultural Research Institute and has been edited by Anil Agarwal. A number of papers have been referred to by the editor. The important ones are: "Scenario for a warm, high-CO_2 world", T.M.L. Wigley, P.D. Jones and P.M. Kelly, Nature, January 3, 1980; "Sensitivity of a Global Climate Model to an Increase of CO_2 Concentration in the Atmosphere", Syukuro Manabe and Ronald J. Stouffer, Journal of Geophysical Research, October 20, 1980; and "Impact of CO_2 Induced Climate Change on Agriculture in Developing Countries", S.K. Sinha, unpublished. The best text for lay persons on the problem of carbon dioxide is the Earthscan Press Briefing Document No. 25 entitled "Carbon Dioxide, The Climate and Man". Voluntary agencies interested in this paper can get it from Earthscan, 10 Percy Street, London W1P for free. The editor has also referred to "Life on a Warmer Earth" by Professor Hermann Flohn, a recent study published by the International Institute for Applied Systems Analysis in Laxenburg, Austria.

HABITAT

The basic text of the Urban Habitat section was written by Ujjayant Chakravorty and edited by Ravi Chopra and Kalpana Sharma.

Since all the national newspapers and magazines are urban based, there is no dearth of literature on the urban environment. Recently published material used in preparing this chapter came from: "The Illustrated Weekly of India", July 5-11, 1981, a special issue devoted to the problems of Bombay; "The soaring cost of land", a special feature in "India Today", July 1-16, 1981; "Can Bombay be saved?", a cover story in "Business India", October 26, 1981 and "Cities", a series of articles that appeared in "The Economic Times" in April, 1982.

With the appearance of glossy city-magazines like "Bombay", "Centre", "Delhi Recorder", "Aside" (Madras) and the more serious "Amdavadma" (Ahmedabad), topical information on the local problems of these cities has become abundant. Information on the plight of small towns, however, is virtually non-existent. "Civic Affairs" which describes itself as a 'monthly journal of city government in India', sometimes contains information on smaller cities. It is available from Citizens Press, Bhargova Estate, The Mall, Kanpur.

Demographic data has been obtained from the 1981 Census of India Reports, Series 1, paper 2, on "Rural-Urban Distribution".

In addition to the above resources, the housing and slums section has been written after referring to the following: "Calcutta's slum improvement: a myth?", by U.N. Chakravorty, CSE report number 9, August 1981; papers presented at a series of national seminars on "Non-conventional and Alternative Approaches to Shelter the Poor", co-ordinated by the Ahmedabad Study and Action Group (Dalal Building, Relief Road, Ahmedabad 380001); India's Country Report submitted to the United Nations Conference on Human Settlements, Vancouver, 1976.

Ramesh Awasthi from Bombay, a volunteer with the Chattra Yuva Sangharsh Vahini which has been active in Tulsiwadi and other slums, provided a detailed profile of the Bombay slums and an account of the efforts by civil liberties organizations to stop Mr. Antulay's slums demolitions drive. The Kerkar Committee Report on Bombay's slums and housing problems and a critique written by Colin Gonsalvez of the Yusuf Meherally Centre (National House, 6 Tulloch Road, Bombay 9) gave the pros and the cons of that report. The subject, however, has only been touched upon in this chapter and awaits better treatment.

For urban water supply, besides clippings from newspapers and magazines, the following resources were consulted: The Sixth Plan

(1980-85) document; issue papers presented at the seminar "Delhi 2001" organized by the Delhi Development Authority; "Status of Urban Water Supply", a Central Public Health and Environmental Engineers' Organization (CPHEEO) Report (1978); "State of water supply and waste water collection and treatment and disposal in Class I and II towns in India" published by the Central Board for Prevention and Control of Water Pollution (CBPCWP), New Delhi (1979-80); notes mailed by Dr. A. Jhunjhunwala of IIT Madras; "Water and Sanitation for All?" and "Water and Sanitation for Three Countries: Colombia, India and Kenya" both of which are Earthscan Press briefing documents and are available from the International Institute for Environment and Development, 10 Percy St. London W1P.

The urban sanitation section is based on the Earthscan documents and the CBPCWP reports cited above, the Draft Fifth Five Year Plan (1978-83) and the Sixth Plan (1980-85) document.

For the urban transport section, besides newspaper reports, the "Report of the National Transport Policy Committee" published by the Planning Commission (1980) has been very useful. Papers read at the seminar on "Transportation Systems in Urban Settlements" organized by the School of Planning and Architecture, New Delhi, in April 1982, have also been consulted.

The Kanpur box item is based on the report of a field trip by P.S. Mauji. Kalpana Sharma and Shahnaz Anklesaria wrote the piece on Shillong after a visit there and after consulting the Shillong Master Plan. "Wheels for the Future" has been contributed by Rajiv Gupta and Anil Agarwal based on newsfeatures that they had done earlier at CSE. The item on Sulabha International is adapted from a CSE feature "Poor Man's Toilet" by Ujjayant Chakravorty. Ashish Kothari and Sunita Narain of Kalpavriksha wrote the text of "Asiad or Bust" and Ravi Chopra provided the accompanying chart.

The Rural Habitat section of this chapter has been written by Anil Agarwal who relied mainly on three sources: the Draft Sixth Five Year Plan; "Water, Sanitation, Health — For All?" Prospects for the International Drinking Water Supply and Sanitation Decade, 1981-90, Anil Agarwal, James Kimondo, Gloria Moreno, and Jon Tinker, International Institute for Environment and Development (IIED), London, 1981; and "Mud, mud: the potential of earth-based materials for Third World Housing", Anil Agarwal, IIED, London (1981). The last two publications can be obtained from Earthscan, 10 Percy St., London W1P. Mimeographed versions, if available, are generally given out free. A good source for information on mud buildings in India is the Centre of Science for Villages, Magan Sangrahalaya, Wardha.

PEOPLE

This chapter has been edited by Kalpana Sharma using reports written by Prof Usha Deka, Dr Urmila Pingle, Dr K.C. Malhotra, Claude Alvares, John Kurien and Smitu Kothari.

Fisherfolk

Compiled by Smitu Kothari with information from Claude Alvares (Goa), and John Kurien and Sebastian Mathew in their report "Technological change in fishing: Its impact on fishermen" and "Entry of big business into fishing: Its impact on fish Economy" by John Kurien.

Tribals

Compiled largely from information provided by Dr Urmila Pingle of Hyderabad and Dr Usha Deka, Reader in Physical Anthropology, Utkal University, Bhubaneswar, Orissa. The item on tribal medicines includes information sent by Darshan Shankar of the Academy of Development Science, Post and Village Kashele, Taluka Karjat, Dist. Kulaba, Maharashtra.

Nomadic tribes

Based on a report submitted by K.C. Malhotra of the Indian Statistical Institute, Calcutta.

HEALTH

This chapter is based on a series of papers released by national and international research agencies like the Indian Council of Medical Research (ICMR) and the World Health Organisation (WHO). The argument that India faces an emerging double burden of disease — the major argument in the chapter — has been taken from 'Health Dimensions of Development', the Second Vikram Sarabhai Memorial Lecture delivered by Dr V. Ramalingaswami, director-general of ICMR.

Data on mortality in India and an analysis of the stagnation in death rates has been taken from the Child Atlas of India published by UNICEF in New Delhi in 1981; Survey on Infant and Child Mortality, 1979: A Preliminary Report, Office of the Registrar General, New Delhi; Health Statistics of India, Central Bureau of Health Intelligence, New Delhi; 'Signs of Change in Developing-Country Mortality Trends: The End of an Era?', Davidson R. Gwatkin, Overseas Development Council, Washington, D.C., 1981; and several WHO publications. The most notable WHO document in this context is the Sixth World Health Situation Report.

For data on resistance of disease vectors to pesticides, it is gendrally useful to watch out for the reports of the WHO Expert Committee on Vector Biology and Control. The data in the chapter is based on the fifth report of this committee published in 1980. A short note on the report entitled 'Resistance of Disease Vectors to Pesticides: Present Status' was published in WHO Chronicle, Vol. 35, No. 4, 1981. An analysis of the implications of the current crisis in vector control for India has been presented by Dr V. Ramalingaswami in 'Vector Control At Crossroads', a keynote address given at the Symposium on Insect Vector Biology in Madras in 1979.

A substantial amount of information on malaria has been taken from 'Malaria makes a comeback' by Anil Agarwal, New Scientist, Vol. 77, No. 1088, 1978. More recent information on the spread of pesticide resistance in the mosquitoes and drug resistance in the Plasmodia (the malaria germs) has been taken from the annual reports of the Malaria Research Centre of the ICMR. Several other papers have been referred to for the preparation of the chapter: WHO Expert Committee on Malaria, Seventeenth Report, WHO, Geneva, 1979; 'Who let malaria in?', S. Pattanayak and V.P. Pathak, Science Today, May 1977; 'Malaria and Agriculture', Volume 10, Number 3, 1979; 'Mosquito-borne disease: a strategy for the future', J.D. Gillett, Scientific Progress, Oxford, Volume 62, pp. 395-414, Oxford; 'The Mosquito: Still Man's Worst Enemy', J.D. Gillett, American Scientist, Volume 61, No. 4 pp. Reservoir and Environs: Tamil Nadu', B. Hyma and A. Ramesh, Social Science and Medicine, Oxford, Vol. 14D, pp. 337-344; and, 'Malaria in India with Particular Reference to two West-Central States', Ashok R. Dutt, Rais Akhtar and Hiran M. Dutta, Social Science and Medicine, Volume 14D, pp. 317-330. The paper by Hyma and Ramesh describes the effect of a new surface irrigation system in Tamil Nadu on the epidemiology of malaria.

The data on filariasis has been taken generally from 'Filariasis spreading' by D. Subrahmanyam, Science Today, April 1982, and from the annual reports of the Vector Control Research Centre in Pondicherry.

Information about cancer has been culled from a range of Indian and WHO publications, namely, 'Challenges and Response: Health in South-east Asia Region', V.T. Herat Gunaratne, Tata McGraw Hill, New Delhi, 1977; 'Is cancer avoidable?', Jan Stjernsward, World Health, WHO, Geneva, 1981; 'Five goals proposed for global campaign against smoking', World Health, WHO, Geneva, 1979; 'Environmental factors in human cancer: some comments', WHO Chronicle, WHO, Geneva, June 1979; 'Kenya Government bans smoking in public', World Health, Geneva, October 1980; 'Environment, cancer and research', John Higginson, World Health, Geneva, June 1978; 'Controlling the smoking epidemic: A summary of the report of a WHO Expert Committee', R. Masironi, WHO Chronicle, Geneva, September 1979; 'Smoking and disease

— what must be done', D. Horn, WHO Chronicle, Geneva, September 1977; 'Cancer Widely Prevalent in 3rd World: Accounts for More than Half of Cases', World Health, Geneva, December 1981; 'Tobacco Smoking in the World', WHO Chronicle, Geneva, August 1978; 'Man-Made Epidemic Threatens Third World', Charles Morrow, In the News, WHO, No. 7, 1982; 'How to Fight Oral Cancer', Jens J. Pindborg, World Health, June 1981; 'Experimental Carcinogenesis vis-a-vis Environmental Carcinogens Specific to India', ICMR Bulletin, January, 1978; and several clippings from the Indian press.

ENERGY

A very large number of papers, newspaper clippings, books and documents have been used to compile this chapter. The most notable ones are: Report of the Working Group on Energy Policy, Government of India, Planning Commission, New Delhi, 1979; Report on Rural Energy Consumption in Northern India, National Council of Applied Economic Research, New Delhi, January 1981; "Alternative Development Strategies with a Low Energy Profile for a Low GNP/Capita Energy-poor Country: The Case of India", T.L. Sankar, mimeographed; "Energy to Liberate Children", A.K.N. Reddy and Srilatha Batliwala, Ceres, FAO, Rome, September-October 1979; "The design of rural energy centres", A.K.N. Reddy and D.K. Subramaniam, in Rural Technology, edited by A.K.N. Reddy, Indian Academy of Sciences, Bangalore, 1980; Economics and Sociology of Alternative Energy Sources by Arjun Makhijani, Regional Seminar on Alternative Patterns of Development and Lifestyles in Asia and the Pacific, Bangkok, August 1979. Fuel Crisis in Rural India, L.C. Sharma, "Commerce", Bombay, November 1, 1980; Energy Balance and Utilisation of Agricultural Waste in a Farm, Final Report of the Project Sponsored by Tata Energy Research Institute, Punjab Agricultural University, Ludhiana, 1980; The Energetics of a Developing Agriculture, B.S. Pathak, Punjab Agricultural University, Ludhiana, mimeographed; Petroleum as Energy Source— Problems and Perspective, R.K.. Bhargava, mimeographed; Agricultural Waste — A case study of cotton stalk, C.G. Ranade and D.C. Sah, Economic Times, New Delhi, January 17, 1982.

On Energy and Women, literature referred to includes: Community Forestry Depends on Women, Marilyn W. Hoskins, Unasylva, Rome, Vol. 32, No. 130; The Implications of Women's Role in Food Preparation in Rural Homes in Nepal, Augusta Molnar, mimeographed; Women in Social Forestry, Zarina Bhatty, paper presented at the seminar on the Role of Women in Community Forestry held at the Forest Research Institute and College, Dehra Dun, December 4-9, 1980; Cooking in the Ungra Area: Fuel Efficiency, Energy Losses, and Opportunities for Reduced Firewood Consumption, Howard S. Geller, Indian Institute of Science, Bangalore, August, 1981.

WILDLIFE

The text of the main chapter has been written by Dr Madhav Gadgil. Topical information has been added by Ravi Chopra and Mahesh Rangarajan.

"Wildlife in India" edited by V.B. Saharia and published by the Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi, is an excellent source book of information and data on the subject. For topical information, there are a number of useful periodicals dealing with wildlife. Among those consulted in preparing this chapter are the 'World Wildlife Fund (WWF) — India Newsletter', 'Indian Wildlifer' and 'Sanctuary'. In addition, a number of newsclippings from the CSE files have been used.

The box item 'Of elephants and people' has been prepared using Dr Gadgil's notes and an article "The Indian Elephant" by M. Krishnan in Sanctuary, January/March 1982.

"Smugglers go wild" has been compiled using the following sources: 'International trade in wildlife' by Tin Inskipp and Sue Wells, an Earthscan news release (1979), 'The International Wildlife Trade', an Earthscan Press Briefing, (document no. 16, 1979); 'Of Parrots, Whales and Cites' by Tim Inskipp Earthscan (1981). India's Orchid Smugglers' by Sumi Krishna Chauhan, Earthscan press release (1981); 'Cites Delhi News' a newsletter published in July, October and December 1980 — in preparation for the Cites meeting in Delhi in February 1981 — by Eco Forum, a bulletin of the European Environmental Bureau. In addition, a number of news reports were also referred to. The more important ones are: 'The poachers are getting away with murder' by Shama Gamkhar, Business India, November 9-22, 1982, 'A Sly Export and Threat to Ecology', The Hindu, April 4, 1982; 'Long road to survival' by Siddhartha Buch, The Hindu, March 28, 1982. The Earthscan publications can be obtained by writing to Earthscan, 10 Percy Street, London W1P. For voluntary organizations, the material is provided free of cost.

Shahnaz Anklesaria wrote the piece on 'Endangered flora and fauna in Northeast India' based on a trip to Assam and Meghalaya. Dr Bhag Singh's comment appeared in a letter to the editor, Voluntary Action.

The list of endangered faunal species is taken from the Wildlife (Protection) Act, 1972.

Romulus Whitaker, Madras Snake Park Trust, provided a few papers on crocodiles and sea-turtles authored or co-authored by him.

Some other informative newspaper articles are: 'Focus on lion-tailed monkeys', The Hindu, March 13, 1982, 'Save Tigers, damn people' by Sumi Chauhan in the Hindustan Times Weekly, March 8, 1981, 'Pushed out by people' by Geeta Aravamudan, India Today, November 30, 1981.

GOVERNMENT

This chapter was prepared with the help of a basic text written by Bharat Dogra and Anil Agarwal. The main documents used for preparing the chapter were the publications of the Department of Environment and the National Committee on Environmental Planning. The chapter is essentially descriptive, and it is based on the department's annual reports, the draft Sixth Five Year Plan, and the report of the Committee for Recommending Legislative Measures and Administrative Machinery for Ensuring Environmental Protection. The latter report was released in 1980 by the Department of Science and Technology, the predecessor of the Department of Environment. It is popularly referred to in the Department of Environment as 'the green book'. A paper written by Dilip Biswas, an officer of the Department, entitled 'Environmental Programmes of the Government of India' is also a good description of the department's activities. Articles published by Thomas Mathew, another officer of the department, who has now resigned to set up the Environmental Services Group under the aegis of the World Wildlife Fund — India, are helpful in evaluating the achievements of the DOE and the NCEP.

A Statement of Shared Concern

With efforts to conserve the country's ecological bank still minimal, India is rapidly becoming a vast wasteland. Indians cannot now close their eyes to this continuing degradation of their natural environment.

As this report shows, the list of environmental problems is too long and the human costs of environmental degradation just too high to allow for any complacency.

It is false to argue that environmental conservation acts as a brake on economic development. On the contrary, the experience gained in the last three decades has convincingly shown that there can be no rational and equitable economic development without environmental conservation. Environmental degradation invariably results in increased economic inequalities in which the poor suffer the most. Environmental degradation and social injustice are two sides of the same coin. The human condition and the state of the environment are closely related to each other.

The kind of economic and social development we want will ultimately determine whether the environment will be conserved or further destroyed. For human beings the environment is not just a pristine collection of natural entities that must be admired, but it is one vast, complex entity that offers a range of natural resources for their use, for their economic and social growth and to meet their material and spiritual aspirations.

In a country like India, with a high population density and high level of poverty, virtually every ecological niche is occupied by some occupational or cultural human group for its sustenance. Each time an ecological niche is degraded or its resources appropriated by the more powerful in society, the deprived, weaker sections become further impoverished. For instance, the steady destruction of our natural forests, pasture lands and inland and coastal water bodies has not only meant increased economic poverty for millions of tribals, nomads and traditional fisherfolk, but also a slow cultural and social death: a dismal change from rugged self-sufficient human beings to abjectly dependent landless labourers and squalor-stricken urban migrants. Current development can, in fact, be described as the process by which the rich and more powerful reallocate the nation's natural resources in their favour and modern technology is the tool that subserves this process.

The resource-use pattern initiated by the current development process is, thus, not just attacking and destroying the environment — the wildlife, forests and fisheries, for instance — but also the vast majority of human being, especially the poor, and their cultures. A development process that does not care for human life cannot care for the human environment or vice-versa. The world's cultural diversity is no historical accident. It springs from the world's biological diversity. And today both stand equally threatened. With each passing day, both the physical shape and the cultural milieu of Bombay nudges closer to New York.

The product-use pattern encouraged by the current development process is such that it is separating people from their immediate environment: the artificial has become the more desirable, the imported environmental misfit has become the more appropriate. This has gone to the ridiculous extent that even such an intimate biological behaviour as breastfeeding is being disrupted by commercial propaganda and mothers, in increasing numbers, are becoming dependent on a supply of multinational milk power, which is lethal when mixed with polluted water.

As an aggressively high-consumption oriented culture intensifies amongst a well-to-do minority across the world, it is creating a rat race amongst the rest, both between and within nations, to become a part of it. The desire to join this growing, multinational culture is so strong that for most people it has left no freedom to choose. The individual has no alternative.

Our growing capabilities in science and technology have helped us to acquire a technological literacy that allows us to converse with the rest of the world as equals and has rightly earned us international prestige amongst the community of nations. But science and technology cannot be allowed to impose their own value system on society. On the contrary, the use of science and technology in society has to the governed by a human, socially appropriate value system. Otherwise we will get a rampant materialism, the extreme symbol of which is the young man amongst us who does not even mind burning his bride if he does not get the promised scooter and refrigerator in dowry.

The culture exported from the so-called developed countries, which we are adopting unthinkingly is at the heart of the crisis. We never ask the question: developing towards what? This growing multinational culture must be destroyed because it leads to economic chaos, increased social disparities, mass poverty and filthy affluence in coexistence, environmental degradation, and ultimately civil strife and war.

To get a balanced, rational development and to preserve the environment, a new development process is needed. The biggest intellectual and political challenge of our times is to articulate and demonstrate this new kind of development.

It is a reflection of our prevalent culture that development has come to mean a mere increase in consumption and production of material goods and services. Development is not a product that can be obtained with economic growth. On the contrary, it is a process which enables all levels of society — individual, community and nation — to become more self-reliant and more independent in choosing and deciding their own future.

Building up self-reliance at the level of the community, without which self-reliance at the level of the nation is, illusory, is not possible without the restoration of human beings, relationships with their immediate environment, and this will require an enormous change in current education, production and product-use patterns, and management and governance of environmental systems and public services. Participatory management, for instance, will be essential. Health, forestry and energy experts all over the world now realise that neither the delivery of basic health services to control the daily epidemic of diarrhoea nor the establishment of community woodlots to increase the supply of cooking energy is possible without community participation. Multinational chemicals are less important for the health problems of developing countries than immediate environmental sanitation, the immediate local herbal wealth and care and development of the immediate agricultural resources to provide adequate nutrition.

Women invariably suffer more from unbalanced development and environmental degradation. As our understanding of both feminist and environmental concerns grows, we find that women are more interested in the restoration of the environment, which provides the family with its basic needs, than their cash-hungry men. Especially within families where basic needs are gathered, it is women who are left to fend for the family. The new development process will demand that women and men share equal power in society.

Thus, an environmentally enlightened development process necessarily demands a new culture, which will be:

* egalitarian, with reduced disparities between rich and poor and power equally shared by men and women;
* resource-sharing;
* participatory;
* frugal, when compared to the current consumption patterns of the rich;
* humble, with a respect for the multiplicity of the world's cultures and lifestyles; and,
* it will aim at greater self-reliance at all levels of society.

The environmental crisis, born out of a global maldevelopment, affects all countries of the world, North or South, East or West. But no country can wait for the rest of the world to find a solution. In India, particularly, the problems are too pressing. We strongly believe that a sustainable egalitarian development is possible if we keep in mind what Mahatma Gandhi once said: There is enough in the world for everyone's need but not enough for everyone's greed.

Anil Agarwal
Claude Alvares
Shahnaz Anklesaria
Ramesh Awasthi
Bhubanesh Bhatt
Chandi Prasad Bhatt
Ujjayant Chakravorty
S. B. Chaphekar
Ravi Chopra
Darryl D'Monte
Usha Deka
Bharat Dogra
Madhav Gadgil
Rajiv Gupta
Shyam Jha
Navin Juyal
K. P. Kannan
Ashish Kothari
Smitu Kothari
Sharad Kulkarni
John Kurien
Kailash Malhotra
Thomas Mathew
Anupam Mishra
Sunita Narain
Sevanti Ninan
Naren Panjwani
Urmila Pingle
M. K. Prasad
Mahesh Rangarajan
Purnima Rao
A. K. 'Dunu' Roy
Kalpana Sharma
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